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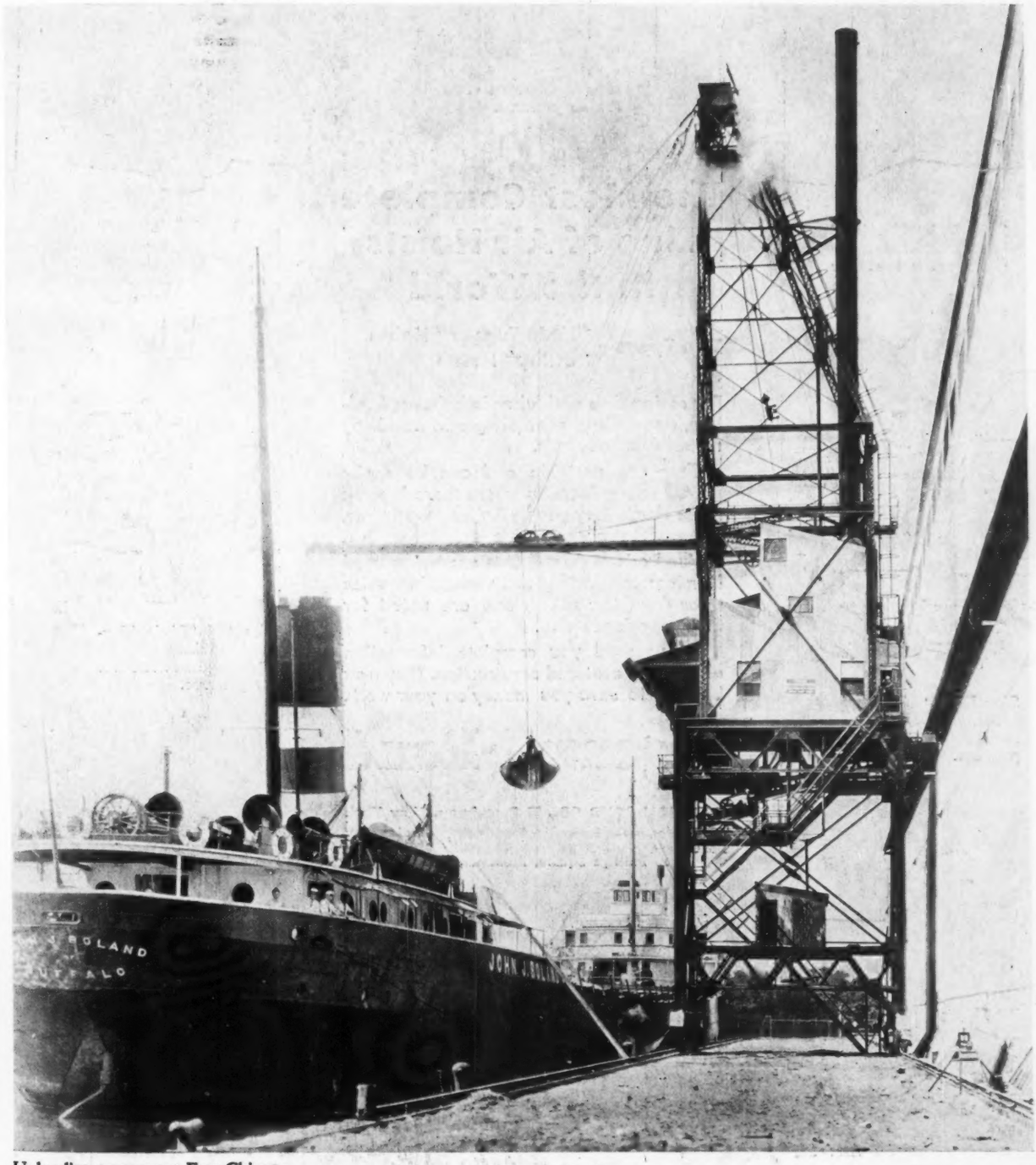

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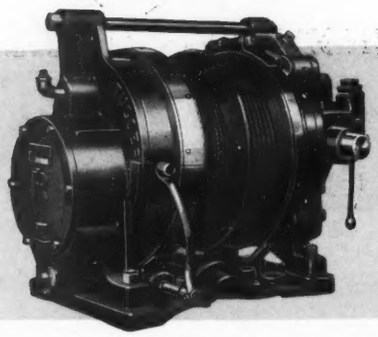

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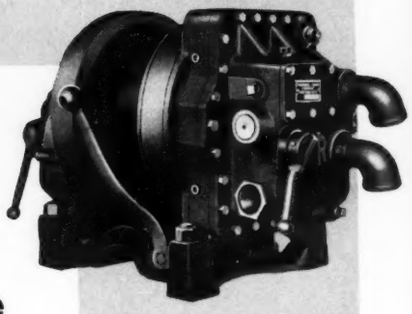

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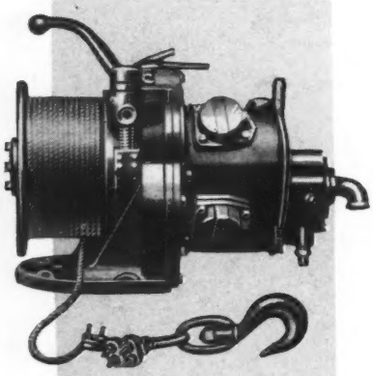

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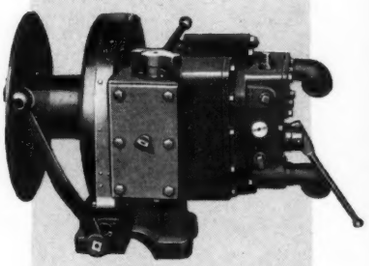

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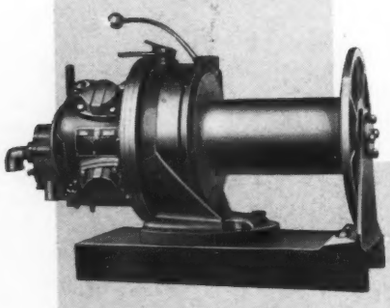

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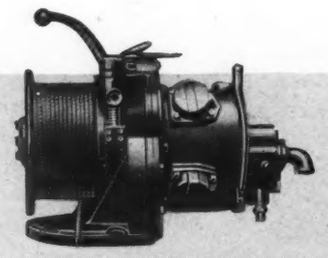

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New York

Contents for August 9, 1930

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McGRAW-HILL PUBLISHING COMPANY, INC., Tenth Ave. at 36th St., New York, N. Y.

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Published semi-monthly. Price in the United States and possessions, 25 cents (U. S. currency) per copy: $4 per year. In all other countries, $20 per year—24 issues. Entered as second-class matter, June 20, 1879, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

Member A.B.P. *Member A.B.C.*

7,800 COPIES PRINTED THIS ISSUE

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PHILADELPHIA, 1600 Arch Street
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ENGINEERING AND
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A. W. ALLEN, *Editor*

VOLUME 130, No. 3

ESTABLISHED 1866

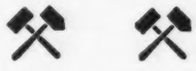
New York, August 9, 1930

The Modern Executive—an Exponent of Co-operation

APPREHENSION is often expressed that the growing mechanization of the present age is tending to make a slave of man and to rob him of his individuality. Machinery is depriving him of opportunity for self-expression, according to those who judge the past by the performance of a privileged few and forget the toil and drudgery of the masses through all ages. The thoughtful observer, however, sees many signs of a growing concern in the wellbeing of those employed by industry, in their safety during the work hours, and in opportunities for their recreation during the steadily increasing hours of leisure.

An entirely new type of executive is under development as a result of these changing conditions. Rule by force and domination no longer gives the best results; careful attention must be given to the human element in management. Modern industry demands a high degree of efficiency from machinery and equipment, and in many instances this development has proceeded to such a point that further progress will be slight. Among his subordinate staff, however, every executive has material that presents almost limitless opportunities for development, and which, if correctly and tactfully handled, offers infinitely greater satisfaction than a mere increase in technical standards. Such success depends upon co-operation, the creation of a well-balanced organization with clearly defined duties and responsibilities. Nothing reflects more creditably upon an executive than an organization that functions as smoothly in his absence as when he is personally in charge, and where no person, not even he himself, has become indispensable and cannot at any time be replaced without impairing results. Such a condition is diametrically opposite to that of old, when each man carefully guarded the details of his work, to prevent other members of the organization from acquiring a knowledge that might enable them to "steal his job." Suspicion and fear are not conducive to good work. Constructive rather than destructive thinking is needed.

Permanency of employment does not in the modern well-managed organization depend largely upon the whim of executives, high or low, but upon proven ability, loyalty, zeal, and accomplishment. The successful executive shares his fortunes with the men under him. As he advances, they will follow. With such an attitude on his part he will soon find that they are pushing him forward, not pulling him back. This truly is co-operation.



Plenty of Smoke But Very Little Fire

BECAUSE the sensational is, after all, the stuff of which the modern daily newspaper is made, probably more publicity has been accorded the efforts of other countries to counteract the new United States tariff bill than they deserve. In this connection the formation of what the press alleges is a combination of European copper producers and consumers, with the object of making Europe self-sufficient in copper supplies, has been given widespread attention. English, German, and Belgian concerns have exchanged stock, with the avowed purpose of increasing "vertical integration," yet hints are plentiful that the real motive is a complete boycott of American copper.

At present European consumption is about double European-controlled production. To bridge this gap, the chief source of potential future production is Northern Rhodesia. By the time the new deposits in that district are delivering copper on a sufficiently large scale to cover the present European deficiency—about 400,000 tons annually—European consumption of copper will probably have expanded with improvement in standards of living. Furthermore, the Northern Rhodesian companies are closely associated with American copper companies they would hardly want to antagonize by a policy of ruthless competition. Finally, with the exception of Union Minière, European-controlled copper producers are comparatively high-cost producers. In a price war, the American producers would probably win. European producers are aware of these facts. *Engineering and Mining Journal* does not believe they would enter upon what appears to be a futile rivalry, and therefore it is not inclined to take reports of a boycott of American copper very seriously.

For every evidence of friction between rival nationalities in the mining industry, as good evidence exists of international co-operation. If newspapers predict trouble between warring groups of copper producers, they also report the reassuring fact that American Smelting & Refining—which has interests in the United States, Mexico, Peru, Chile, Newfoundland, Canada, and the Balkans—has acquired a substantial shareholding in Mining Trust, which is operating in Australia, New Guinea,

France, and Northern Rhodesia. Economists declare that war arises largely from economic rivalry. Cannot the opposite be said—that the principal deterrent to war is economic co-operation and that the world-wide ramifications of the mining industry, which are constantly being knit more closely together, are at least one augury of continued peace?

Safety Pays—So Say the Ledgers of Industry

THE vice-president of one of the foremost mining companies in the United States, whose offices are in New York City, remarked recently, in commenting on accident prevention, that he, as the chief executive in charge of the company's operations, was more responsible for the safety of the company's employees than were the several plant managers. This responsibility of his, he explained, was entirely executive in character and took little of his time. Nevertheless, it was all-important, inasmuch as it comprised (1) requiring certain results from each subordinate in direct charge of safety, and (2) replacing those subordinates whose results did not meet predetermined requirements.

Although the enforcement of safety programs by chief executives is not common, a tendency to expand this practice prevails. One reason for this trend is that the financial benefits accruing from "higher-up" administration of accident-prevention endeavor are of sufficient magnitude to warrant the attention of such executives. This conclusion is borne out by an announcement, which recently emanated from a reliable source, to the effect that the Buick Motor Company, after five years' safety work, found that it had saved $300,000 and protected between two and three thousand men; the American Smelting & Refining Company decreased its former accident rate 76 per cent and concluded that it has saved nearly $2,000,000; the United States Steel Corporation estimated the return on its safety investment at $5,000,000.

These figures are impressive and substantiate the principal contention that the leaders in accident-prevention work have held since its inception: that safety pays. Widespread knowledge of this truth will result in business insisting on the utilization of practices initiated by the humanitarians; but that will not detract one iota from the importance of the early work of the humanitarians.

Rich Ore at Depth in the Kolar Gold Field

IN THE experience of most miners, veins of gold-bearing ore do not improve in grade as the depth of mining operations increases. Pinching-out at depth is an all too common phenomenon. The news from the Kolar gold field, in India, that an entirely new and rich orebody has been discovered at a depth of 6,500 feet from the surface, is therefore heartening. This discovery has been made to the south of the central oreshoot, in the neighborhood of Glen's shaft. For 2,000 feet above, the vein had been practically barren; then, between the sixty-ninth and seventieth level, a small body of medium-grade ore was developed. This improved with downward development: on the seventy-first level, over a total length of 622 feet, a forty-inch vein averaged 1 oz. 6 dwt. ($26); and for 100 feet, or so far as development has gone on the seventy-second level, at a depth of nearly seven thousand feet, a 4½-foot vein of ore averages a little over two ounces per ton, according to the latest information that has been made available.

Operations as deep as those in the Kolar field—well over a mile—are expensive, for many reasons. Men, supplies, and ore must be transported over long distances. Ventilation of the hot workings is a serious problem; and the great pressure at such depths makes the hazard of a rock-burst a constant menace. One- to two-ounce ore will be a welcome contribution to the usual run-of-mine product.

At the annual meeting of the company, in London, the Chairman, the Hon. A. T. J. Fraser, said: "It is always rather rash to make the statement that a given phenomenon has never previously occurred in history, but I make bold to say that there are at any rate very few instances, in the history of mining, of a new oreshoot of such strength and value commencing at such a depth." Readers who have experienced or who have heard of other outstanding examples of vein enrichment at depth, below a thousand feet or so of a barren or low-grade ore channel, are invited to contribute the details to our pages, so that those who have had the opposite experience, but who are still at work, may find added encouragement.

Uses for Germanium Should Be Developed

ELECTROLYTIC REFINING of metals has made possible the recovery of secondary metals that are present in amounts so small that they cannot be economically extracted, for their own value alone, by other methods. Of first importance in this group are silver, gold, and the platinum metals, but others, such as selenium, antimony, and bismuth, are also among the valuable byproducts of electrolytic refining processes.

In the electrolytic production of zinc the recovery of small amounts of cadmium, the presence of which was formerly considered a detriment rather than an asset, has for several years added to the commercial value of the process. Lately attention has been drawn to germanium, another rare metal occurring in many zinc ores, although in even far smaller amounts than cadmium. No use has yet been found for this metal, so its presence brings more grief than profit. The fact that, comparatively speaking, an appreciable supply of this exceedingly rare element has been found, however, should stimulate research to study its qualities and to determine to what extent it may be made useful. The highly specialized demands of modern science make probable a successful outcome of such an investigation, in which eventually the metal, that is now considered to be an objectionable impurity, may in some not far-distant day be classed among income-earning byproducts.

Property and Operation of Patiño Mines and Enterprises at Llallagua, Bolivia

R. R. Beard

THE MINES and mill of Patiño Mines & Enterprises, Consolidated, Inc., are situated at Llallagua, Province of Bustillo, Department of Potosi, Bolivia, about 120 km. (74.6 miles) by rail southeast of the city of Oruro, which is on the main line of the Antofagasta-Bolivia Railway. The Machacamarca-Uncia Railroad, owned by the company, connects Llallagua with this main line at the town of Machacamarca, 24 km. (14.9 miles) south of Oruro. Short branch lines of seven and three kilometers (4.3 and 1.9 miles), respectively, connect Uncia with the millsite and general administration center of Catavi, and Catavi with Siglo XX, where the mine offices and sorting plant are situated. Reference to the sketch map will make these relative locations clear.

Bolivia has no seaboard, and access is gained normally through the Pacific ports of Mollendo, Peru; Arica, or Antofagasta, Chile; or by rail from Buenos Aires. The route by Antofagasta is that generally preferred, as the ascent is more gradual and allows greater opportunity for the body to become accustomed to the rarefied atmosphere.

The first of a series of articles on the leading mining operation in Bolivia.

Sketch map of Llallagua and vicinity

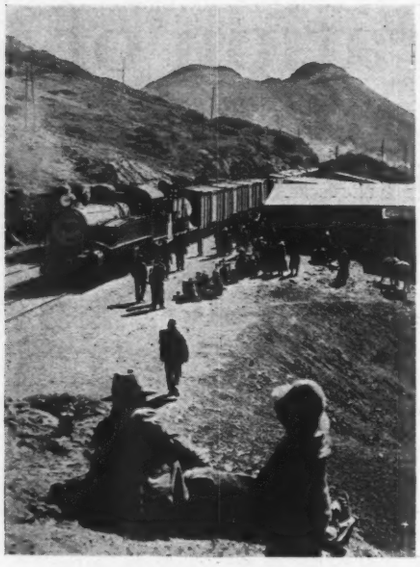
Catavi, Bolivia

In 1928 the Antofagasta-Bolivia Railway placed in effect a direct service from Antofagasta to La Paz, obviating the disagreeable necessity of changing trains at Uyuni. The trip from Antofagasta to Oruro, a distance of 930 km. (577.9 miles), can now be made in 24 hours. Sleeping- and dining-car accommodations are good.

The lofty plateau of Bolivia, with an average elevation of 12,000 ft. and a width of 90 miles, runs between the Cordillera Occidental and the Cordillera Real. The Cordillera Real, or eastern range of the Andes, constitutes one of the world's greatest mountain systems. Several peaks exceed 21,000 ft. in height. Llallagua lies on the eastern watershed of the Cordillera Real, at an elevation varying from 12,250 ft. at Catavi to about 15,000 ft. at the topmost mine working, La Salvadora. All drainage is to the tributaries of the Amazon.

The climate at Llallagua is mild and agreeable. Snow occurs but rarely and then remains only a few hours. In the winter months, May to and including September, the nights are cold enough for the formation of ice, but climatic conditions are never sufficiently severe to interfere with mining operations. Precipitation is confined to the summer months of October to and including April. The rainfall, as recorded at Catavi, was 25.50 in. in 1927, 26.09 in. in 1928, and 17.51 in. in 1929. High winds that usually prevail in August and September constitute the most disagreeable weather condition. The days are warm, the tropical sun largely offsetting the effect of the altitude. Llallagua is but 17 deg. south of the Equator. The immediate surrounding country is barren of any natural growth of trees, and only small shrubs are present. Insect pests, encountered in the lowlands, are extremely rare in the higher altitudes.

Originally the property now owned by Patiño Mines & Enterprises consisted of the two properties of Uncia and Llallagua, situated in the same mountain. In many instances the same vein was worked by both, the drifts in some operations being connected. The Salvadora mine, of the Uncia property, was first worked by Sr. Simon I. Patiño about 25 years ago. His belief in the property, and its subsequent developed richness, enabled him to obtain and equip the adjacent mines, later known as Uncia. The Llallagua mine, on the opposite side of the mountain, is said to have been worked as



Llallagua station, on the Machacamarca-Uncia Railroad

early as 1880. In 1906 the mine was acquired by the Cia. Estañifera de Llallagua, a Chilean corporation, which continued operations until it was absorbed in 1924 by Patiño Mines & Enterprises. The Uncia and Llallagua properties, individually, were the greatest tin mines in Bolivia and possibly in the world; collectively, in 1929, they produced 49 per cent of the total tin of Bolivia and about 11 per cent of the tin production of the world.

Patiño Mines & Enterprises was organized on July 5, 1924, under the laws of the State of Delaware, U. S. A., for the purpose of acquiring the properties of Uncia, owned by Señor Patiño, and of Llallagua, owned by the Cia. Estañifera de Llallagua. The issued capital of the company consists of 1,380,316 shares of a par value of $20, or $27,606,320 U. S. currency, equivalent to £6,250,000. The authorized capital is $50,000,000, consisting of 2,500,000 shares of a par value of $20.

In addition to the two tin-mining properties, the corporation also owns the Machacamarca - Uncia Railroad. This was formerly owned and operated by Señor Patiño, who built it under a special government concession granted in 1911. Through a subsidiary company, the corporation has recently acquired the tin-smelting plant of Williams, Harvey & Company, at Bootle, Liverpool, England.

The mining properties of the company include more than 4,700 acres of mining and placer ground, as well as millsites, camp sites, and water rights that exceed 1,600 acres in total area. Two artificial lakes are included, in which water is stored during the rainy season for the development of hydroelectric power.

Lack of records covering the earlier years makes it impossible to state with accuracy the total amount of tin produced, but Table I shows the production during the later and more important years. At an average selling price of £250 per long ton, the gross value of the combined production of the two properties would reach the enormous figure of £63,654,275, equivalent to about $310,000,000.

The production of 20,926 long tons of fine tin in 1929 constitutes a record. This is of interest in comparing the treatment of large tonnages of medium-grade ore with operations on a reduced scale but under bonanza conditions, such as existed prior to 1920. From 1924 to and including 1929, the corporation has paid dividends amounting to £5,038,152, or about $24,500,000.

The principal part of Salvadora

Table I—Production of Fine Tin

Year	Empresa Minera Salvadora (Uncia), in Long Tons	Cia. Estañifera de Llallagua, in Long Tons	Total
1906	.....	1,111.7	1,111.7
1907	.....	2,005.7	2,005.7
1908	.....	2,563.2	2,563.2
1909	.....	2,506.4	2,506.4
1910	5,125.8	2,709.9	7,835.7
1911	3,916.4	2,402.0	6,318.4
1912	4,870.3	2,315.0	7,185.3
1913	5,753.4	3,382.4	9,135.8
1914	3,109.5	3,460.0	6,569.5
1915	5,356.1	3,733.7	9,089.8
1916	5,722.1	5,096.1	10,818.2
1917	5,282.9	7,917.8	13,200.7
1918	6,149.0	12,484.5	18,633.5
1919	5,514.7	10,400.6	15,915.3
1920	5,221.9	11,228.8	16,450.7
1921	5,478.1	4,924.5	10,402.6
1922	5,856.3	10,913.0	16,769.3
1923	5,661.1	10,819.3	16,480.4
1924	.....	.....	11,525.9
1925	.....	.....	10,032.0
1926	.....	.....	9,696.6
1927	.....	.....	12,155.5
1928	.....	.....	17,288.6
1929	.....	.....	20,926.3
Grand total.....			254,617.1

mountain, in which the veins occur, is composed of an intrusive quartz porphyry, approximately 1,000 m. (3,280 ft.) wide by 1,400 m. (4,590 ft.) long. This intrusive cuts a sedimentary series, composed of graywacke, quartzite, and slate, in the form of a steep anticline. The porphyry has been intensely fractured, and this is true, although to a lesser extent, of the sedimentaries. The veins, usually small in size, occur in tension and contraction cracks, and in zones of fracture. Although the fractures may continue both horizontally and vertically, apparently the tin mineralization does not do so to the same extent. The largest vein, the San Fermin-San Jose, shows a maximum length of 700 m. (2,297 ft.), and is said to have been up to four meters (13 ft.) wide in places.

Tin mineralization is confined almost exclusively to the quartz porphyry, probably 90 per cent of the total tin production having come from within the area occupied by this intrusive. The veins have steep but varying dips, approximating 75 deg. on the average. They may be considered vein systems with numerous branches. Up to the present time 45 major veins with 456 distinct branches have been noted. These are inclosed within a rough oval, about 1,300 m. (4,266 ft.) long by 900 m. (2,952 ft.) wide, with a vertical extension of 775 m. (2,543 ft.).

Most of the veins do not appear to outcrop. This is because of splitting in the upper levels, and owing to the fact that large areas of surface are covered with thin soil and decomposed porphyry. Oxidation is irregular. In the larger veins it may extend as much as 500 ft. below the surface; in others no more than 100 ft. In very few of the veins were commercial quantities of tin found until a considerable depth below the surface had been reached. In the oxidized zone the cassiterite remains unaltered and is associated with the usual decomposition products of the metallic sulphides. An enrichment apparently occurred in this zone, but it was probably the result of removal of iron and sulphur in pyrite and other sulphides, by the leaching action of

Siglo XX from a near-by vantage point. Llamas are seen in the foreground

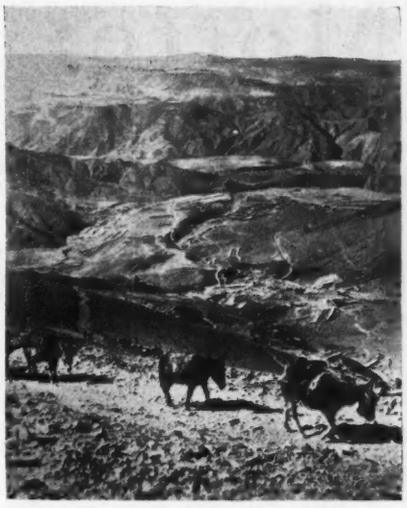
meteoric waters, rather than by the addition of tin in secondary form. The mine waters in some sections carry varying amounts of tin in solution, which is considered to have resulted from the leaching of stannite, a mineral that is present in small amounts. The veins offer varying degrees of resistance to percolating waters. This, no doubt, is one reason for the different depths of oxidation. In general the veins are parallel and have northeast-southwest strike, some dipping to the northwest and some to the southeast. The distance between the veins may vary from a few feet up to several hundred feet. They are comparatively narrow, the stoping width for 1928 being 1.16 m. (45.7 in.). This, of course, includes a certain amount of unmineralized wall rock.

About 45 distinct mineral species have been noted in the mine, although but few of them occur in any quantity. Pyrite and quartz are the most common. Cassiterite, or tin dioxide, is the only tin mineral of importance. Other characteristic minerals occurring in lesser amounts are marcasite, pyrrhotite, arsenopyrite, wolframite, wavellite, tourmaline, and vivianite. Pyrite is the most common associate of cassiterite, although in some of the high-grade veins it may be almost absent. The cassiterite occurs in crystals lining vugs or open cracks, in crusts and sheets, and in scattered grains intermixed with metallic sulphides. It is massive or finely crystalline, and of an unusually dark color. Minerals such as tourmaline, quartz, and wolframite, which vary as to the temperature of deposition, have been considered as indicators as to the exhausting of commercial values of tin, but no definite and reliable data have been obtained on this point.

Among the minerals noted are allophane, apatite, arsenopyrite, cassiterite, chalcanthite, chalcocite, chalcopyrite, copper (native), copiapite, franckeite, galena, greenockite, hisingerite, jamesonite, kaolinite, limonite, marcasite, metavauxite, monazite, paravauxite, pyrargyrite, pyrite, pyrrhotite, quartz, rhodocrosite, scheelite, siderite, sphalerite, stannite, tourmaline, tetrahedrite, vanadinite, vauxite, vivianite, wavellite, wolframite, and xenotime.

Llallagua is the type locality for vauxite, paravauxite, metavauxite, and hydrous phosphates of iron and alumina. These have been found in no other district. They were described by Samuel G. Gordon in the Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 75, 1923, pp. 261-270.

The veins have been developed by 25 levels, at vertical intervals of 30 to 35 m. (98.4 to 114.8 ft). More than 140 km. (87 miles) of accessible workings are within the mine. Previous to 1924, in both the Uncia and Llallagua properties, all ore was mined by underhand stoping methods. Shrinkage stoping was adopted in the early part of that year, as being more suitable for prevailing conditions, in addition to being safer and cheaper. All ore is now removed in this manner. The chief disadvantage of shrinkage stoping, as applied here, was the excessive overbreak, resulting in undesired dilution. By careful supervision, however, this difficulty has been overcome and the miners have been taught to break only the necessary width for the proper removal of the ore. The ground stands well, and but little timbering is required. No pillars are left unmined, except where necessary, and then only floor pillars for the support of haulage levels. The average stope is about 40 m. (131 ft.) long. Broken ore is removed after completion of a stope, these stopes are then filled with waste to prevent further caving of the walls.



Cancaniri, Llallagua, and Siglo XX from La Salvadora, the highest mine working

The sorting of "guia" or high-grade shipping ore was practiced within the mine prior to 1927. This has been discontinued, as the method made difficult an estimate of the grade of ore broken in stopes, and offered opportunity for theft. More than 500 air drills are used in the mine, and some hand drilling is done. The air requirements are supplied by six compressors, varying in capacity from 1,300 to 5,300 cu.ft. each per minute.

For several years before the consolidation, the Uncia property was worked through a long crosscut tunnel known as Socavon Patiño, driven in a northerly direction. The total length of this tunnel is 1,970 m. (6,464 ft.), with a branch 630 m. (2,067 ft.) long. Later, a shaft was sunk from Socavon Patiño and a 1,000-m. (3,281-ft.) crosscut was driven to a point 57 m. (187 ft.) above the Siglo XX tunnel. Socavon Patiño and Socavon Siglo XX are connected by a shaft 274 m. (899 ft.) deep.

The Llallagua company, in its later years, developed its side of the mine through the Socavon Siglo XX, a tunnel driven in a southerly direction at almost the bottom of the orebodies. This is about three kilometers (1.86 miles) long, with branches aggregating 1.35 km. (0.84 miles). It is now the principal operating tunnel, through which all ore of commercial grade is delivered to the Siglo XX crushing and sorting plant.

The ore is collected from the various workings by chutes, and thence hand-trammed in 1-ton cars along track of 50-cm. (19.7-in.) gage to the main ore passes, which carry the material by gravity to the Siglo XX tunnel level. This avoids almost all hoisting of ore, although there are thirteen operating shafts for the transportation of men and materials. In the Siglo XX tunnel, as well as in certain of the retramming levels, haulage is done by electric locomotive with 2-ton cars of 60-cm. (23.6-in.) gage. All development headings are standard, 1.8 x 2.1 m. (6 x 6.9 ft.), and all haulage tunnels, 3.0 x 3 m. (9.8 x 9.8 ft.) in cross-section.

With 207 stopes and 320 development faces, ore is being extracted from about 400 different sources. About 50 per cent of the total ore mined is being broken in stopes, the remainder coming from old fills, pillars, dumps, and development headings. Of the total ore mined, about 35 per cent is rejected before being sent to the concentrator; 15 per cent of this is disposed of as waste within the mine, and 20 per cent is removed in the crushing and sorting plant.

The mine is divided into eleven sections, each a complete unit. All ore is mined on a contract basis. The mine is dry and well ventilated. About 400 gal. of water per minute is pumped from the central gathering sump below the Siglo XX tunnel.

Development work is well planned in advance to keep pace with the ore extracted. This is evidenced by the fact that the ore reserves, instead of decreasing, have materially increased during the last few years. The total development and exploratory work since 1926 is given in Table II; and reserves are shown in Table III.

Table II—Development and Exploratory Work

	Meters	Miles
1926	9,583	5.95
1927	15,407	9.57
1928	20,010	12.43
1929	25,346	15.75
Total	70,346	43.70

Table III—Estimated Ore Reserves

	Total, Dry Metric Tons	Tin Per Cent	Tin, Metric Tons
Dec. 31, 1925	1,061,000	4.74	50,289
Dec. 31, 1926	1,070,883	4.77	51,045
Dec. 31, 1927	1,231,091	4.74	58,346
Dec. 31, 1928	1,605,637	4.45	71,462
Dec. 31, 1929	1,964,864	4.20	82,606

(To be continued)

Mine La Motte:

A Historic Lead Property in Southeast Missouri

H. D. Keiser
Assistant Editor

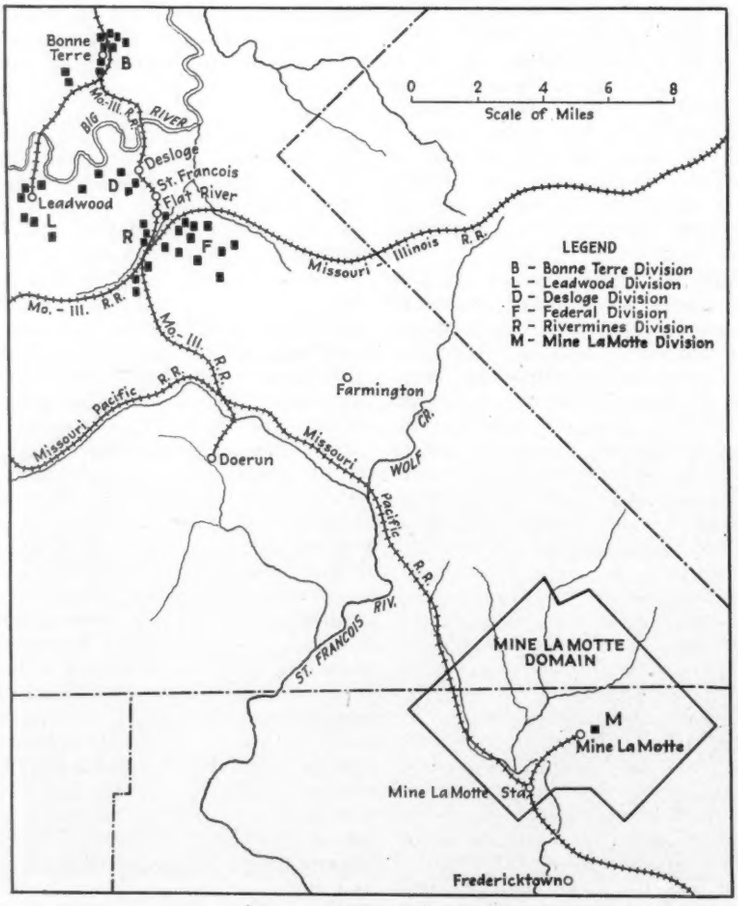
OPERATIONS of the St. Joseph Lead Company in the Southeast Missouri district cover an area of more than 100 square miles, and are grouped into six divisions, as shown in the accompanying sketch map. Each division is a complete mining and milling unit, under the direction of a division superintendent. At the time of my recent visit to the district the following tonnages of ore were mined daily in the respective divisions: Bonne Terre, 2,500; Leadwood, 3,000; Desloge, 3,000; Federal, 5,500; Rivermines, 4,500; Mine La Motte, 1,000.

One of the most interesting of these divisions is Mine La Motte (owned jointly with the St. Louis Smelting & Refining Company), not only because current operations on the tract comprise a comparatively new undertaking of the company but also on account of the unusual historic significance that attaches to the property.

According to early records of exploration on the North American continent, samples of copper ore were obtained from the Mine La Motte deposits in 1541 by Fernando De Soto, the Spanish explorer. The next white man to visit the property was Phillip Francis Renault, a native of Picardy, France, who sailed for the New World in 1719 in search of silver and gold. Renault was a practical miner, and brought with him 200 mechanics from Europe and 500 slaves from the West Indies. Inasmuch as he did not find silver in paying quantities associated with the lead, Renault abandoned the property in a few years. In 1725 one of his party, named La Motte, reopened the mine, and operated it for several years. About 1730, the mine came to be considered public property, near-by inhabitants working it at will.

Much of the lead used by the American forces in both the French and Indian and the Revolutionary wars was secured at Mine La Motte. A shot tower for converting Mine La Motte lead into bullets was built at Herculaneum, Mo., in 1809. The output of this tower was used by the American government in the War of 1812. The tract then became involved in prolonged litigation as a result of ownership claims, being acquired in 1861 by Philadelphia interests. Shortly thereafter, following the outbreak of the Civil War, the mine plant was destroyed by Union forces, because lead for the Confederate army was being obtained from the property. The mine has been worked intermittently in subsequent years during the course of successive transfers and leases to various interests, operations on the tract finally being assumed in 1925 by the St. Joseph Lead Company.

Reminiscent of the early "public-property" operations at the mine are the activities of itinerant diggers, who, each year, with the coming of warm weather, establish their camps near the old workings and spend the summer months extracting high-grade ore from surface gouges. This ore is purchased in small lots by the company and credited to the digger's account. No rental or royalty fee is charged. Half payment is made at the time of each sale, settlement of the account taking



Sketch map of the Southeast Missouri district, showing the six operating divisions of the St. Joseph Lead Company

place when the digger's sales total a carload.

Mine La Motte is situated 5 miles northeast of Fredericktown, Mo., and about 30 miles southeast of Bonne Terre—the district headquarters of the St. Joseph Lead Company. Current operations, which are in virgin territory near the eastern boundary of the tract and more than a mile from any of the earlier workings, were undertaken following extensive diamond drilling of the area from the surface.

Development of the property proceeded from a 6x8-ft. vertical shaft that was sunk 235 ft. to the ore horizon. Joplin-type buckets were used, the ore being shipped to the company's Federal mill at Flat River. Development work was suspended toward the close of 1927. The shaft, which is now known as No. 18, was enlarged to 6x16½ ft., and construction of a 1,000-ton mill was started. Both the shaft and mill were placed in operation early in 1929, since which time mining and milling have been continuous at the property.

The ore deposits, which vary from a few feet to 80 ft. in thickness, are found in a lime-cemented sand immediately above the La Motte sandstone formation. The galena occurs both disseminated and in the form of narrow bands, ranging from less than an inch to 12 in. in thickness. Outcrops of the ore, as well as deposits lying more than 1,000 ft. below the surface, are found within the boundaries of the tract.

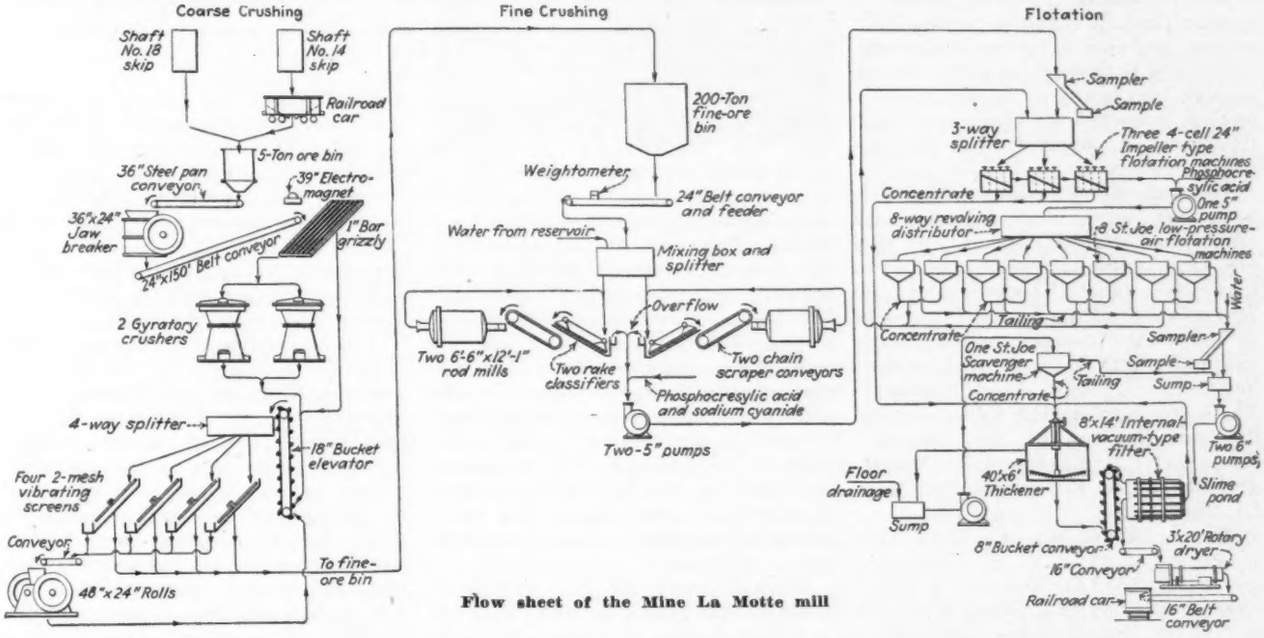
The ore is mined in open stopes supported by pillars. Stoping width varies from 8 to 35 ft., averaging about 10 ft. Pillar spacing ranges from 25 to 45 ft., and pillar diameter from 15 to 25 ft., according to the height of the stope. An ore extraction of about 82 per cent is obtained, 18 per cent of the ore being left in pillars. Drifts are 10x10 ft. in cross-section. Six stopes and two drifts are being worked at present.

All drilling is done with jackhammer drills equipped with air-feed cylinders. In drilling drift rounds, which consist of 24 or 26 holes, the drill is mounted on a column. For drilling "lifters" in the stopes or other flat holes along the floor, a "spike" board is used. This consists of a board with a spike driven in it, near one end. The drill rests on the board, the end of the air feed cylinder being placed against the spike. By blocking the board so that it cannot move backward, the air-feed cylinder automatically advances the drill steel as drilling proceeds. Lubrication of the drills is effected by means of line oilers, which inject oil into the compressed-air lines. In drifting, holes are drilled 8 to 9 ft. deep, whereas 10-ft. holes are drilled in stopes. Cap-and-fuse blasting is practiced in the stopes, but electric-battery firing, up to and including fourth-delay caps, is employed in drifting. Forty per cent gelatin dynamite is used in both drift and stope blasting.

All underground loading of ore is done mechanically. In each of the two drifts that are being advanced, a loading machine of the belt-conveyor type is used. Each machine is driven by a 30-hp. motor, and is moved forward on extensions of the haulage line into the drift. Mucking crews, working on two four-hour or split shifts, operate the machines. Each of the two eight-hour underground shifts is followed by a four-hour or split shift. A drift round is fired toward the close of each eight-hour shift, the normal advance being 5 ft. per shift, or 10 ft. per day. In the course of the split shift, after the blasted material has been loaded, the haulage line is extended into the drift by the mucking crew. A temporary 5-ft. section, consisting of two 5-ft. lengths of rail supported on several cross-pieces of channel iron, is used for this extension of the line. The section is placed on wooden ties, each channel-iron cross member fitting over the top of one of the ties. As the line is extended into the drift, the temporary sections are replaced, four at a time, with 20-ft. permanent rails. These are laid during the eight-hour shifts.

Ore broken in the stopes is loaded with St. Joe mining shovels, 160 to 300 tons being loaded with each shovel per shift. Usually, a minimum of 400 to 500 tons of broken ore is made available before a shovel is moved into a stope. These shovels are of the improved low-head type, as shown in two of the accompanying illustrations. The general design of the shovel, prior to the adoption of recent improvements that resulted in reduced overhead clearance and other desirable features, has already been described.[1] A brief summary of the recent improvements follows:

1. The dipper was changed in width from 2 ft. 10¾ in. to 3 ft. 10¾ in., and in depth from 2 ft. 5½ in. to 18 in. It was also made 1 ft. shorter, by decreasing by 9 in. the radius from the center of the dipper pin to the end of the dipper lip, and by reducing by 3 in. the radius from the dipper pin to the back of the dipper. The A-frame sheave was lowered 1 ft. and advanced 1 ft. This change resulted in more power being required for hoisting, and therefore a 20-hp. motor was substituted for the 12-hp. hoist motor. The boom legs were lengthened 1 ft., and the operator's seat was lowered. From their former



Flow sheet of the Mine La Motte mill

[1] **"Mechanical Underground Loading in Metal Mines," Charles E. Van Barneveld, School of Mines and Metallurgy, University of Missouri, 1924.**

position under the operator's seat, the accelerating switches were moved out to a position on the side of the shovel above the crowd chains.

The aforesaid changes resulted in the machine being lowered one foot. This reduced the overhead clearance to 6 ft. 2 in.

2. All shafts and clutches were changed to high-grade chrome-manganese steel.

3. The use of friction clutches on motor shafts has been abandoned; instead, magnetic solenoid brakes have been adopted. If a coil burns out, it can be replaced in five minutes, whereas 3½ hours was required to repair a friction clutch.

4. The bearings of all the motors have been changed from plain to ball bearings.

When a shovel is to be moved to another place, it is run up a ramp built of ties and onto a special steel truck. This truck is then transported over the haulage lines by one of the electric locomotives to the new working place, where the shovel is unloaded under its own power.

To watch one of the improved shovels in a 7-ft. stope, loading broken ore rapidly and steadily into ore cars that are 42 in. high above the rail, is an impressive sight. Unquestionably, the shovel is one of the outstanding pieces of equipment developed in the mining industry. Fifty of the shovels are used by the St. Joseph Lead Company. These are distributed as follows among the six divisions of the company: Bonne Terre, 4; Leadwood, 7; Desloge, 4; Federal, 16; Rivermines, 16; Mine La Motte, 3.

The ore cars at Mine La Motte have a capacity of 48 cu.ft., or 2.7 tons of ore; weigh 3,450 lb.; and have a swivel coupling at either end. Three 6-ton and two 4½-ton electric trolley locomotives, each of which is equipped with a 500-ft. cable reel for gathering purposes, are used in assembling the loaded ore cars into 8-car trains and in hauling the trains to the car dump at the shaft. A gage of 24 in. and both 56- and 60-lb. rail are used on the main haulage lines; 30-lb. rail is employed elsewhere. At the rotary car dump, which is electrically operated and is of the company's own design, three cars are dumped at a time without uncoupling. The ore falls into a 300-ton skip pocket, and thence passes through two gates into the skips. The gates, operated by compressed air, are tended by a skip loader. Each of the two skips has a capacity of 5 tons, but this has been reduced to 2½ tons by a false bottom. The lower portion of the skip has been converted into a man cage.

One of the St. Joe mining shovels, with dipper in dumped position above a loaded car

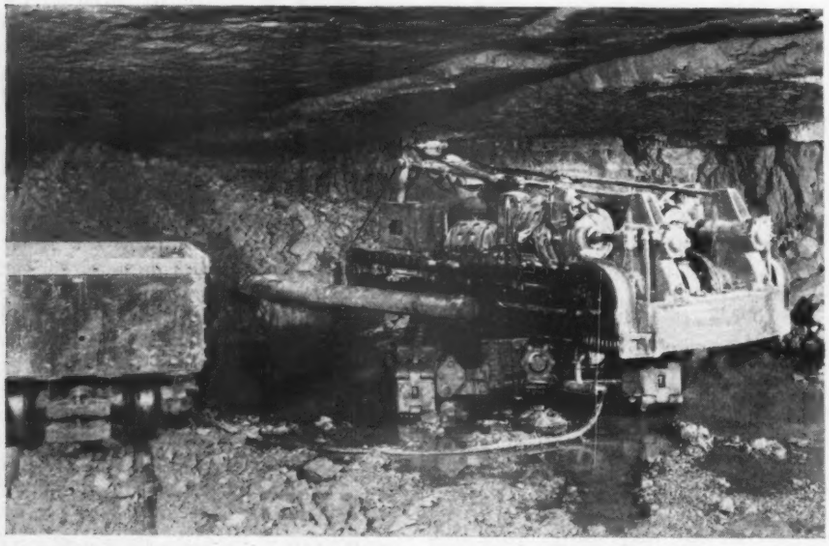
Electric power for the shovels is brought underground at 440 volts. In each drift leading to a stope in which a shovel is working, three 15-kva. transformers reduce this 440-volt current to 220-volt, 3-phase, 60-cycle alternating current. The shovels are operated at this low voltage to insure safety and for the same reason the shovels are grounded by a separate ground wire included in the feed cable. Power for the electric trolley haulage lines is 250-volt direct current, which is also brought underground from the surface.

Natural ventilation is employed. This is obtained through No. 18 shaft and numerous 6¼-in. churn-drill holes. These drill holes are put down from the surface in the course of current prospecting and become part of the ventilation scheme as soon as they are intersected by underground development. Another shaft, No. 14, situated about half a mile west of No. 18, has recently been sunk and is now being equipped. It will provide additional ventilation facilities that will be utilized as the workings become more extensive.

All underground water drains to a sump at the shaft, where two single-stage 3-in. centrifugal pumps force the water to the surface at the rate of 75 g.p.m. Drill steel is sharpened at an underground blacksmith shop, which is equipped with a sharpening machine, an oil forge, and a dressing wheel. Adjoining the blacksmith shop is a motor repair pit, where the underground electrical equipment is maintained in operating condition.

As shown in the accompanying flow sheet, the skip bins at No. 18 shaft discharge into a 50-ton ore bin situated alongside the headframe and directly beneath the surface level. At No. 14 shaft, ore will be discharged from the headframe bin into railroad cars. These cars will then be transported to No. 18 shaft, where they will be spotted above, and discharged into, the 50-ton ore bin.

A 36-in. steel pan conveyor, operated by a 5-hp. motor through a variable-speed drive, takes the ore from the ore



The new low-head St. Joe mining shovel, with dipper in shoveling position and crowding into the ore

bin and feeds it into a 36x24-in. jaw breaker. From the breaker, operated by a 100-hp. motor, the ore falls onto an inclined belt conveyor, 24 in. wide and 150 ft. long, operated by a 25-hp. motor through a worm-gear speed reducer. This conveyor carries the ore to the top of the mill building. Tramp iron in the ore is removed by a 39-in. electromagnet placed above the wooden head pulley of the conveyor. The ore is discharged by the conveyor onto a bar grizzly, spaced at 1 in., the oversize from which passes in two equal portions to two gyratory crushers. Individual 50-hp. motors drive the crushers. An 18-in. bucket elevator takes the product of the crushers and discharges it into a four-way splitter, which distributes the ore equally to four 40x84-in. 2-mesh electrically vibrated screens. Oversize from the screens is conveyed to a 48x24-in. set of rolls, operating in closed circuit with screens. The roll product is returned to the elevator ahead of the screens. Undersize of the screens passes to a steel, cylindrical, fine-ore bin, having a capacity of 200 tons.

A 24-in. belt conveyor, which also acts as a feeder, takes the ore from the fine-ore bin and discharges it into a mixing box. Here, the ore is mixed with water and split into two streams, each of which passes to an 8-ft. 4-in. by 30-ft. duplex rake classifier. Sands from the classifiers are fed by chain scraper conveyors to two 6-ft. 6-in. by 12-ft. 1-in. rod mills, each of which operates in closed circuit with one of the two classifiers. An individual, 240-hp., 2,200-volt motor drives each rod mill. Overflow of the classifiers, averaging 28 per cent solids, passes to two 5-in. pumps, where phosphocresylic acid and sodium cyanide are added. The stream formed by the combined discharge of the two pumps is sampled by a mechanical sampler and is then equally distributed by a three-way splitter to three four-cell 24-in. flotation machines of the impeller type. These machines are arranged in parallel and produce a finished concentrate froth which passes to a 40x6-ft. thickener. The tailing goes to a 5-in. pump, where additional phosphocresylic acid is added, and then, by means of an eight-way revolving distributor, it passes to eight St. Joe low-pressure air flotation machines, six of which are 42 ft. long and two of which are 36 ft. in length. Concentrate from the machines is returned to the three-way splitter ahead of the three impeller-type machines. Tailing is sampled mechanically as it passes to a sump, from which it is pumped 8,000 ft. to a slime pond by means of two 6-in. pumps, driven by individual 75-hp. motors.

Solids from the concentrate froth thickeners pass to an 8-in. bucket elevator which discharges into an 8x14-ft. drum filter of the internal-vacuum type. Overflow from the filter is returned to the thickener, joining the concentrate from a St. Joe scavenger machine, the feed to which is composed of floor drainage and the overflow from the thickener. Tailing from this scavenger machine passes to the main sump, where it joins the tailing from the eight St. Joe machines and is pumped 8,000 ft. to the slime pond by two 6-in. centrifugal pumps, driven by individual 75-hp. motors.

Headframe of No. 18 shaft

The dewatered product of the filter, which contains about 8 per cent moisture, falls onto a 16-in. belt conveyor, discharging into the hopper of a 3x20-ft. oil-fired rotary drier of the concurrent type. In the drier the moisture content of the concentrate is reduced to 5 per cent. On leaving the drier, the concentrate falls onto a 16-in. shuttle belt conveyor. This conveyor discharges inside of a railroad box car, which type of car is used in transporting the concentrates from the mill to the smelter.

The average grade of the ore milled is 4 per cent lead; the concentrate averages 75 per cent lead, and the tailing 1 per cent lead. An average screen analysis of the concentrate is: 80 per cent minus 200 mesh; 10 per cent plus 200 mesh; 5 per cent plus 150 mesh; 4 per cent plus 100 mesh; and 1 per cent plus 65 mesh. Reagent consumption per ton of ore treated averages 0.4 lb. of phosphocresylic acid and 0.025 lb. of sodium cyanide. Steel rods, 3½ and 4 in. in diameter, are charged into the rod mills at the rate of 1½ lb. per ton milled. A charge of 66,000 lb. is used in each mill, and a speed of 16½ r.p.m. is employed.

Each of the eight units of the St. Joe flotation machines is equipped with an individual blower of the single-stage compressor type, directly connected to an 18-hp., 3,600-r.p.m. motor.

In addition to the aforesaid mechanical sampling in use at two points in the mill, hand samples are taken at regular intervals of (1) the flotation concentrate, immediately ahead of the thickening tank; (2) the tailing from each impeller-type flotation machine; and (3) the combined flotation concentrate from the St. Joe machines. A representative sample is also taken of each carload of concentrate shipped to the smelter; and from this sample the lead and moisture content of the shipment are determined. The weight of each shipment is carefully checked on a railroad-track scale situated at the property. Shipments are transported over a 5-mile railroad line on the property to the Mine La Motte station of the Missouri Pacific Railroad, and thence over the Missouri Pacific lines to near-by smelting plants.

The mill, with its numerous motors for individual pieces of equipment, is under full automatic control, and the control panel provides, in addition, complete double protection. Another unusual feature is an automatic system of heating the mill during cold weather.

Electric power at 33,000 volts is brought onto the property over duplicate transmission lines of the Union Electric Light & Power Company. This power, after being reduced to 2,300 volts by substation transformers, is distributed on the property over three circuits—namely, the mining, milling, and outlying power circuits. The power consumed at various points is determined with numerous meters that are so placed as to permit an accurate distribution of power costs.

No. 18 shaft, consisting of two skipways and a combined pipeway, cableway, and manway, is equipped with a 72-ft. steel headframe and a 5-ft. 5-in. single-drum hoist, driven by a 75-hp., 2,300-volt motor. The diameter of the hoisting cable is 1⅛ in., and that of the sheaves is 7 ft. The steel headframe recently erected at No. 14 shaft is 56 ft. 5½ in. high. A 4½-ft. single-drum hoist, driven by a 75-hp. 2,300-volt motor, will be used. The diameter of the hoisting cable is 1 in. and that of the hoisting sheaves is 5 ft.

Water for milling purposes is obtained from the slime pond, where a dam built across a valley impounds not only the mill tailings but also the run-off waters of the surrounding area. Water for the mill passes into the intake compartment of a reinforced-concrete "overflow-intake" tower, erected out in the pond, about 100 yd. from the dam. The tower consists of three compartments — one intake and two overflow. A concrete tunnel, built along the bottom of the pond, conveys the overflow water to waste on the other side of the dam. From the intake compartment, the water for milling flows into a 10-in. cast-iron pipe line that rests on top of the concrete tunnel.

This pipe line passes through the dam and into a concrete pump house, where one of two 5-in., single-stage centrifugal pumps, operating under a 250-ft. head, pumps the water 8,000 ft. through an 8-in. pipe line, at the rate of 700 g.p.m., to a 200,000 gal. storage reservoir, near the mill. The pumps are driven by individual 75-hp., 2,300-volt motors. They are automatically controlled, and are interlocked, so that the spare unit is started immediately whenever the operating unit fails.

Compressed air for underground operations is supplied by two duplex compound compressors, rated at 1,000 cu.ft. per minute and driven by individual 200-hp., 2,300-volt motors. Both compressors are in operation during the eight-hour shifts, but only one is used on the four-hour or split shifts. Two 275-volt, 100-kw., motor-generator sets supply direct current for the underground haulage lines. Two steam locomotives are employed in transporting concentrate shipments and supplies over the 5-mile railroad line to Mine La Motte station. The surface plant includes a change house, carpenter shop, a machine shop and storeroom, round house, and office building. A working crew of about 160 men is employed at the property, about 90 men comprising the underground force. Much attention, both on the part of the management and the employees, is directed toward safety measures and welfare endeavor.

Acknowledgment is made to Mr. Clinton H. Crane, president of the St. Joseph Lead Company, for permission to visit Mine La Motte and to prepare the foregoing account, which is based on information released by members of the company's operating staff.

Cooling Drinking Water for Miners' Use

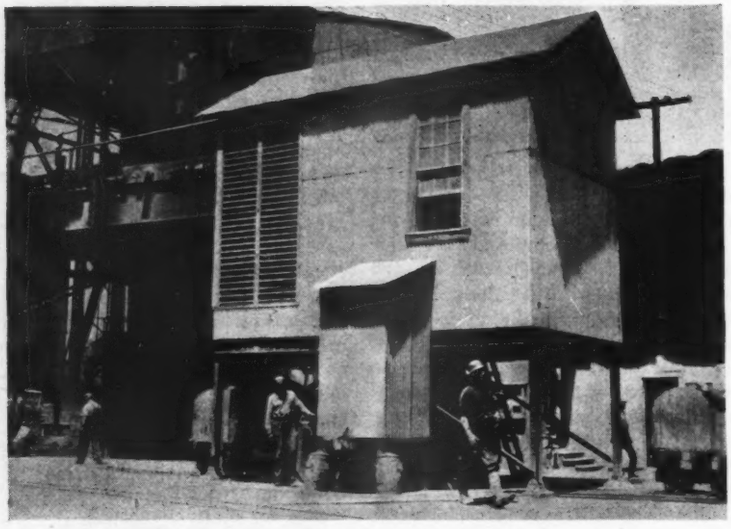


Fig. 1—Tank house and cooling unit at the Junction shaft

Fig. 2—Mine water tanks for use at underground stations of Junction shaft

A SUPPLY of cool drinking water for use underground and on the surface, especially where underground and summer temperatures are higher than ordinary, aids materially in promoting efficiency. That the supply should also be safeguarded from contamination and that sanitary precautions be taken in its distribution are, of course, essential. In most instances, sanitary fountains suffice for the surface plant, and, where the water supply is not cool enough, improvised coolers are employed at the fountains. Sometimes a cold spring is available underground, but ordinarily special attention must be given to the cooling and distribution of drinking water for underground consumption. Usually ice is provided, but proper sanitation in its handling and use is difficult.

A well-planned water-cooling plant at the Junction shaft of the Calumet & Arizona Mining Company, at Lowell, Ariz., which was designed by E. F. Irving, of the mine staff, has satisfactorily solved the drinking-water problem in this section of the company's operations. The unit, which is shown in Fig. 1, consists of a housed-in, 2,000-gal., wooden tank, placed close to the shaft and elevated so that underground water cars can be run under it for filling. The tank house is at one end of the platform and is well ventilated by louvers. A 5-ton Arctic ice machine, at the other end of the platform, supplies the cooling medium, which passes through coils submerged within the tank. A pump circulates the water in the tank, and an automatic temperature control cuts out the ice machine when the contents of the tank reach a temperature close to freezing. The tank is filled from the ground level by means of a system of pipes and valves. A small tank is provided close to the ground level for the drinking water supply used on the surface.

For underground use, galvanized steel tanks, mounted upon trucks, as shown in Fig. 2, are filled and distributed at the different mine levels. Small, 5-gal., wooden water kegs, with faucet and galvanized steel cap, as shown in Fig. 3, are provided for distribution of water in different working places and in the shops of the surface plant. The tight lid on the keg has some disadvantages, but the keg is convenient for filling and for inspection, besides having the advantage of low conductivity. Canteens can be readily filled at the faucet. A small, metal water container would require insulation of some kind, and would have to be heavy enough to withstand rough handling.

About 1,900 gal. of water is consumed on the day shift and 1,200 gal. on the night shift. The cooling unit is started in sufficient time to permit the water cars to be filled and lowered at the beginning of the shift. The arrangement provides an economical method of supplying cool drinking water, without the use of ice.

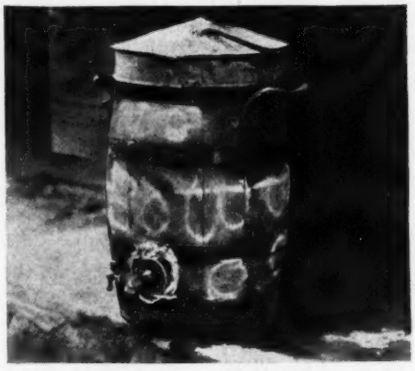


Fig. 3—Water keg for distribution of drinking water at surface and underground

A Nickel-Copper Deposit in New Brunswick, Canada

Bela Low

Mining Engineer, New York

A brief description of the geology and a summary of the exploration work and of an electrical and a magnetic survey, undertaken in a new district, with an outline of the metallurgical research for treating the ore.

DEVELOPMENT of a new mining district has frequently caused civilization to follow in its wake: where the pioneering prospector found a deposit in a remote district, communities and towns have eventually sprung up. The opposite has happened rarely; seldom have new metal-mining enterprises been undertaken in a populated area where hitherto no mining had been carried on. Such is the case, however, near St. Stephen, in New Brunswick, where exploration on a nickel-copper prospect was started about eighteen months ago by New York interests. St. Stephen is a seaport town of about 3,000 inhabitants, on the St. Croix River, which constitutes the boundary between New Brunswick and Maine. The prospect is situated about 2 miles north of the town. Though the mining district is new, it enjoys unusual facilities. The Canadian Pacific Railroad crosses the east line of the property, which is also traversed by several government highways. An additional advantage, especially for the directors of a possible future company, is its distance of only forty-five minutes by automobile from St. Andrews, a beautiful Canadian summer resort.

About forty years ago, sulphides were found in this locality, and a few pits and trenches, and one short diamond-drill hole, were put down at that time. After that, the property remained idle until the beginning of 1929.

Geology—As in many glaciated areas, rock outcrops are few. The geology is a stock-like mass of gabbro intruding an older series of schists and some altered impure sandstones, which presumably are of Silurian age. Sedimentary rocks strike slightly north of east and dip steeply. The gabbro consists largely of anorthite, orthorhambic and monoclinic pyroxene and olivine, with accessory magnetite and pyrrhotite, and thus closely resembles the norite, the parent rock of Sudbury nickel ores.

Fig. 1—Map showing location of St. Stephen, N. B., and its railroad connections

Regarding the genesis of the deposit, Sydney H. Ball, who made a geological report of the property, states that the sulphides were probably deposited by hot waters originating in the gabbro mass soon after it solidified. These waters presumably carried not only sulphur, iron, copper and nickel, but also potassium and silica, as indicated by the occurrence of biotite and quartz near the sulphide masses. The constituents of the gabbro mass, particularly feldspar, where the rock was shattered, were replaced by the elements carried by the waters, resulting in the deposition of massive sulphide in places and of sulphides of disseminated particles elsewhere.

Although pyrrhotite is disseminated here and there in the sedimentary rocks, particularly near the edge of the gabbro, sulphide masses have been found thus far only within the gabbro and in proximity to the gabbro-schist contact. See the detail in Fig. 2. Between sulphide masses and gabbro the contact is sharp. The former consist of rather solid pyrrhotite, containing copper and nickel, so that the type of mineralization is identical with that of Sudbury. The relation of copper to nickel is also the same as the general relationship at Sudbury, or about two parts of nickel to one part of copper, but the copper-nickel content is lower than in any operating mine of Sudbury. An average analysis of the ore of the main lens which was explored is as follows: 45.5 per cent iron, 24.5 sulphur, 0.9 copper, 1.5 nickel, 0.1 cobalt, 30c. gold, $\frac{1}{4}$ oz. silver, 0.1 per cent zinc, and 0.007 per cent phosphorus. Platinum, arsenic, antimony, or lead are not present.

The nickel content is uniform. Of 140 assays of cores from this lens, only 17 were below 1 per cent and 9 above 2 per cent in nickel. The copper content is somewhat more irregular. Of the same 140 assays, 24 were below 0.5 per cent and 27 above 1 per cent in copper; of the latter 2 were between 1.5 per cent and 2 per cent and 2 above 2 per cent. The nickel is more or less proportionate to the total sulphide, but the copper content is about the same, on the average, in the massive sulphide as in the leaner material. In other words, where there is a greater admixture of gangue, the proportion of copper to sulphides, and thus also of copper to nickel, is larger than in the massive pyrrhotite.

The known lenses are overlain by 2 to 8 ft. of overburden, followed by a few inches of gossan.

Exploration Work—Most of the exploration work has been done on a sulphide body situated on what is known as Rodgers Farm. A total of about 2,000 ft. of trenching and 4,000 ft. of diamond drilling has been done. The map in Fig. 3 shows the trenches on the Rodgers lens, which has a surface outline embracing 15,000 sq.ft. Diamond

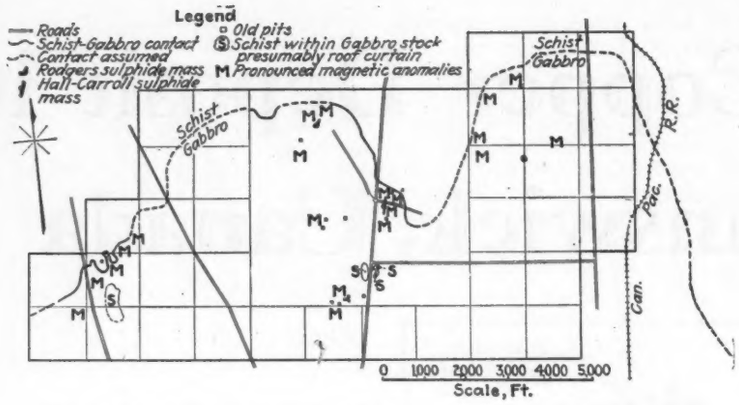


Fig. 2—Schist-gabbro contact and the location of two sulphide lenses and magnetic anomalies

drilling has failed to cut sulphides lower than 250 ft., and the lens has the appearance of tapering to this point. Assuming that it has the shape of an inverted pyramid, the apex being at the lowest point where sulphides were cut and the base being represented by the surface outline of the sulphide mass, the total tonnage indicated is about 150,000. The lens is not necessarily limited to this tonnage, as it might continue in a direction in which no drilling has been done. Two thousand feet south of this, on what is known as the Hall-Carroll property, some trenching was done and two diamond-drill holes were put down which disclosed a sulphide body, approximately 400 ft. long, varying in width from 10 to 28 ft. It is of an average lower copper-nickel content than the Rodgers lens. This vein-like mass is not considered of great importance.

Electrical Survey—Before any diamond drilling was undertaken, an electrical survey was made on the Rodgers, Hall-Carroll, and intervening ground. This was done by the Taumac Corporation. Its method was purely inductive, as no contact with the ground was made, either at the transmitting or receiving loop, and the direction of the secondary electric field in the ground was investigated. A frequency of 2,000 cycles was employed.

The territory between the Rodgers and the Hall-Carroll lenses showed no conductors of importance. Therefore no further prospecting was done there. At the time the survey was made there were only two old pits on the Hall-Carroll property which showed pyrrhotite; the trend of the sulphide body was not known, nor was it apparent whether the sulphide in these two old workings corresponded to the same mass. The results of trenching checked well with the electrical conductor outlined in the survey, although the width proved less than indicated. On the Rodgers lens a strong indication of the presence of a conductor coincides well with the known sulphide lens, as the map in Fig. 4 shows. A conductor southwest of the main lens, which was of equal strength, proved upon trenching to represent merely disseminated sulphides of narrow width. An equally strong electrical conductor running north from the main lens (only its beginning is shown on map) could not be checked up by further work. Trenches there showed only a few patches of sulphides and mostly barren gabbro. It was thought that the conductor may represent a blind sulphide mass, but two diamond-drill holes which were put down failed to disclose anything which could account for an electrical conductor of such strength and length.

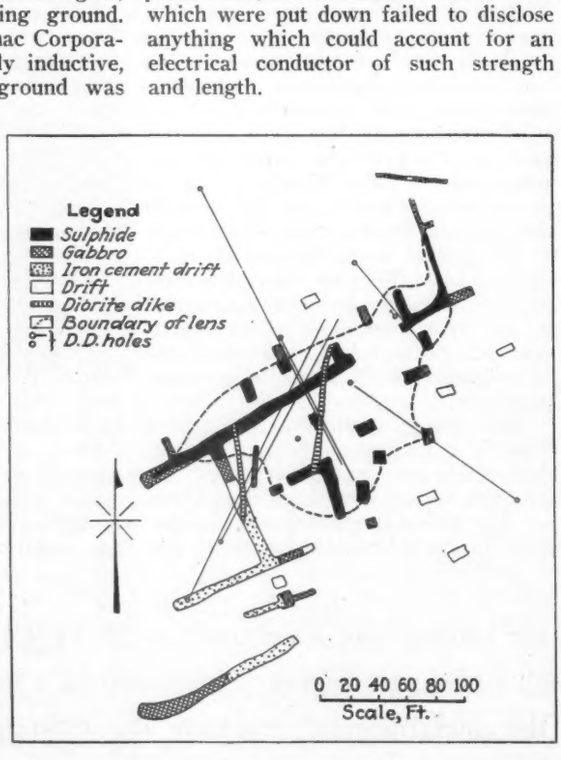


Fig. 3—Trenches and diamond-drill holes on Rodgers lens

Magnetic Survey—As outcrops are scarce, the area being partly farm land and partly timber of second growth, it was deemed best to establish favorable locations for additional exploration by means of a magnetic survey. Most of this work, as well as the mapping of the geology, was ably done by W. Koch, who also supervised trenching and diamond-drilling operations. In the course of the geological work, numerous old pits showing pyrrhotite were found. An interesting fact is that when the town of St. Stephen built a trench for laying a water line, outside of the property, the work unexpectedly disclosed 8 ft. of massive pyrrhotite. All this indicated a widespread mineralization.

It seemed evident that other pyrrhotite lenses than the two herein described exist within the property, and it was thought that they could be best located by a magnetic survey. This survey was made with a miner's dip needle.

Drill of New Brunswick government on Rodgers property

First magnetic readings were taken over the known pyrrhotite bodies. The map in Fig. 4 will show that over the Rodgers lens there is a fairly abrupt change from positive to negative readings, and that the contour of the negative magnetic readings agrees rather well with the surface outline of the sulphide body. The meaning of the small area of anomaly south of the main lens, and of the electrical conductor running south, is not yet apparent.

At a number of places, regions of magnetic anomalies were found. In some these are very pronounced, as for instance in the southwest part of the property close to the contact, where there is an abrupt change in readings from plus 63 to minus 90 within a distance of 20 ft. At some places the compass pointed south and at others east instead of north. Map No. 2 shows those locations where seemingly important magnetic anomalies have been determined and also that most of these are in the vicinity of the contact. No exploration work has as yet been done along these magnetic anomalies, but the logical assumption is that they represent pyrrhotite bodies. Their importance and grade can naturally be determined only by subsequent exploration work.

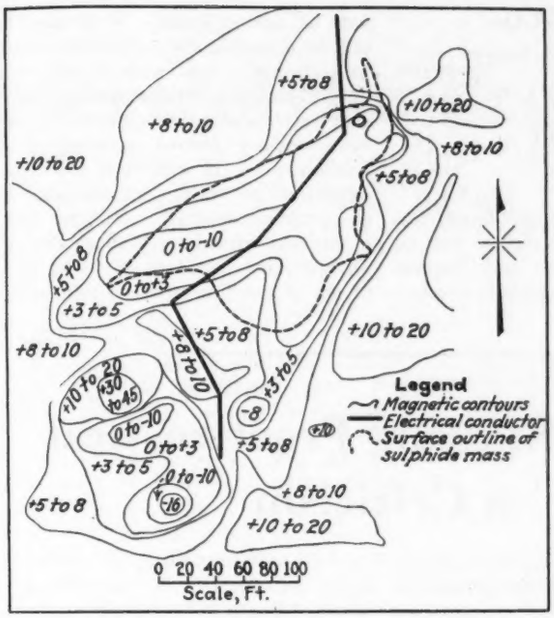


Fig. 4 — Dip-needle readings and position of electrical conductor in relation to surface outline of Rodgers lens

Metallurgical Research—After delineating the Rodgers lens by diamond drilling, an experimental research was undertaken to determine whether such kind and grade of sulphide as was already known to exist could be considered as commercial ore. Although the copper-nickel content was low, it was thought that, owing to the high sulphide content and the favorable geographical location, with low freight rates to markets, the sulphur and iron content might be of economic value. With smelting practice as used at Sudbury, all the iron and an appreciable part of the sulphur is lost. Tests were therefore carried out to determine whether it was possible to put copper, nickel, iron, and sulphur each into a separate marketable product.

Flotation tests were made by the General Engineering Company, which showed that the sulphide is not amenable to differential flotation. The nickel is finely disseminated, and possibly occurs partly as solid solution in the pyrrhotite, so that no satisfactory preferential nickel concentrate is obtainable. Although the copper occurs in well-defined separate crystals of chalcopyrite, the tests made thus far have failed to produce a satisfactory preferential copper concentrate. Where the resulting copper concentrate was of a fair grade—say 10 per cent or so—the copper recoveries were low, varying from 50 to 77 per cent, and, unfortunately, the better the copper recovery, the more nickel was carried into the copper concentrate. In the event of the sale of this product to a copper smelter, this not only means a loss of nickel, but the presence of a deleterious substance which would be penalized. However, by means of a bulk flotation, practically all of the gangue can be eliminated, whereby a high sulphide concentrate can be produced at good recovery. The results of one of these tests in which the heads were crushed to 80 mesh is given in the table below.

Table I—Flotation Tests, Rodgers Lens

(Figures in Percentages)

	Weight %	Copper %	Nickel %	Iron %	Sulphur %
Heads.....	100.00	0.95	1.45	46.9	25.0
Concentrate.	69.02	1.28	1.93	56.8	34.2
Tailing.....	30.98	0.22	0.39	24.9	4.5
Recovery		92.8	91.7	83.6	94.4

To determine the further treatment of these concentrates, representative samples of the massive pyrrhotite were used, of which a composite sample assayed: copper 0.89 per cent; nickel 1.71; iron 53.4; sulphur 31. Assumption was made that the chemical results obtained with this would apply also to concentrate, inasmuch as the massive sulphide is mineralogically and physically identical with it, and differs only in containing a little more gangue with a consequent lower content of the metallic sulphides.

Experimental research for the purpose of developing the metallurgical process was carried out by John H. Banks & Son, and was metallurgically directed by Charles S. Witherell.

Samples ground to 60 mesh, on being roasted in the muffle, showed that the pyrrhotite roasts easily and at low temperature, no sintering taking place. Temperature control proved important, because at high temperatures the copper was converted into insoluble ferrates. That ferrates exist was actually proved, in approximately the same manner as described by Hamilton Murray and McIntosh in the July, 1917, *Bulletin* of the Canadian Institution of Mining and Metallurgy, for proving the existence of zinc ferrate. By giving the sample a slow roast, with gradually rising temperature which was held between 500 and 510 deg. C. for the final hour, and leaching with dilute sulphuric acid solution, a copper extraction of 87.5 per cent was obtained. At the same time, 14.9 per cent of the nickel went into solution. The copper thus extracted by means of a sulphate leach could be recovered by electrolysis, and the nickel, recoverable by known methods of evaporating and crystallizing out of the spent electrolyte, would be returned to the process, as subsequently shown. The iron oxide residue, after the copper has been leached out, contains about 2 per cent nickel. Inasmuch as blast furnace operators pay little or nothing for this nickel content, the problem of separating the nickel arose.

The experimenters found that on roasting at a temperature most favorable for extraction of copper, the bulk of the nickel was unaffected and remained as a sulphide. The residue, after being roasted and leached of its copper, consisted, therefore, mainly of iron oxide, and of nickel and a little iron sulphide, with a small amount of unroasted chalcopyrite. That the nickel could be recovered from this product by means of flotation seemed a reasonable assumption. A few small-scale tests made by The Dorr Company resulted in a nickel recovery of 68.6 per cent in the form of a concentrate assaying 14.4 per cent nickel and 0.92 per cent copper, the ratio of concentration being 8.5 per cent of the weight of the heads. As will be noted, most of the unroasted chalcopyrite is simultaneously recovered, the recovery of copper in this step being 71.5 per cent of that contained in the leached residue. It is reasonably certain that more extensive flotation tests would result in an improved nickel recovery, inasmuch as too few tests were made to cover the field of possible reagents and re-treatment steps.

Receiving loop used on electrical survey

Total recoveries of nickel and copper in the two steps—namely, the sulphate leach and nickel flotation, figured back to the copper and nickel content of the roasted material—show the following figures: Nickel recovery by leaching, 14.9 per cent; nickel recovery in nickel concentrate, 58.4 per cent; total nickel recovery, 73.3 per cent. Copper recovery by leaching, 87.5 per cent; copper recovery in nickel concentrate, 8.9 per cent; total copper recovery, 96.4 per cent.

Table II. Estimated Marketable Recoveries From 100 Tons of Ore

Shipping Products	Weight, Tons	Constituent	Per Cent	Content, Tons	Per Cent Recovery, from— Ore	Concentrate
		Ni	19.12	1.10	73.3	83.1
Ferronickel.....	5.75	Fe	79.42	4.56	10.0	12.7
Iron oxide.....	47.56	Fe	63.74	30.3	66.6	84.6
Copper.....	0.79	Cu	99.8	0.79	87.8	91.4
Copper slag.....	0.03	Cu	33.0	0.01	0.9	0.9
Sulphur dioxide gas...	42.00	S	50.0	21.00	82.4	93.6

Nickel concentrate, together with the nickel crystals recovered from the electrolyte, would subsequently be roasted, and presumably about 75 per cent of the copper content of this material would be recovered by a second leaching. The remaining iron-nickel product, which would be low in copper, sulphur, and silicon, could be reduced to a fairly pure ferronickel, containing about 20 per cent of nickel.

Tailing from the nickel flotation consists of iron oxide assaying about 64.20 per cent iron, 0.40 nickel, 0.05 copper, and 0.25 sulphur, and is low in phosphorus. Before marketing this as an iron ore, it would have to be either sintered or briquetted.

The tests indicate the possibility of a method involving a regulated roast, by which the copper would be rendered soluble and the nickel, which remains largely as an insoluble sulphide, made amenable to separation by flotation, at the same time leaving an improved iron product as a salable residue. This step of preferential roasting preceding the flotation operation is believed to be a novel one.

The SO_2 resulting from the roasts could either be converted into sulphuric acid, or, after purification, sold to near-by pulp mills as liquefied sulphur dioxide. The latter alternative seems the more promising.

A tabulation of the estimated marketable recoveries resulting from 100 tons of ore assaying 1.5 per cent nickel, 0.9 per cent copper, 45.5 per cent iron, and 25.5 per cent sulphur is given in Table II, above.

Treatment of the ore by means of a chloridizing roast, which would make the copper and nickel amenable to leaching, was considered. Such a method was used by Victor Hybinette in Norway, years ago. A few chloridizing tests were made, the best result showing an extraction of 73 per cent nickel and 86 per cent copper. Better copper recoveries were obtained, but coincident with these the nickel recovery showed a decrease.

It was found that when the roasting temperature was maintained at a low point, notably higher extractions of both nickel and copper were obtained, but unfortunately at the same time considerable iron went into solution. Since the treatment of sulphate solutions, particularly by electrolysis, is much less troublesome than that of chloride solutions, the method described, involving sulphate leaching of the copper, followed by flotation to separate the nickel, seems preferable.

The metallurgical research work thus indicates that the objective of putting the copper, nickel, iron, and sulphur each into a separate marketable product can be accomplished. A process that will be economically satisfactory, as well as technically applicable, seems reasonably certain of consummation, but further tests, and on a larger scale, would be necessary before arriving at final conclusions. If sufficient ore can be developed to justify an adequate scale of operation, estimates indicate that, by a process based on laboratory tests, an operating profit of $3 to $4 per ton of ore of existing grade would be made.

Novel Blasting Practice, and a Criticism

THE practice in blasting of inserting the detonator in a non-explosive cylinder of wood or other material is referred to in a paper by John Christie entitled "The Explosives Industry in South Africa, with Special Reference to Rand Mining," which was presented at the recent Empire Mining and Metallurgical Congress in South Africa. Until recently, according to Mr. Christie, the practice was to insert the detonator in one of the explosive cartridges of the charge. An innovation adopted in the Witwatersrand gold mine is to place the detonator in a cylinder of inert or non-explosive material. The inert primer is made of wood, cement. or wax, and is of approximately the dimensions of an explosive cartridge.

A length of capped fuse is threaded through a hole in the primer. The capped end is then dipped into a suitable cement, such as hot glue solution, or a molten wax-resin mixture, and drawn into position in the primer so that the end of the detonator lies flush with the end of the primer. In wooden and cement primers the hole is constricted at a point where the shoulder of the detonator should normally lie, to the extent that the detonator is automatically stopped at that point and in correct position.

The advantages claimed for the inert primer are the assurance that the capped fuse contained is preserved from danger of detonation by shock, and that the detonator can be pushed hard against the explosive without risk. Early experiment with the inert primer brought to light an interesting and important point concerning its use. Various types of primers were being tested, some having the capped fuse contained in a hole bored on the axis of the primer, and others having it bored diagonally. In the latter the detonator naturally did not lie along the same line as the explosive in a borehole. Tests were carried out in an improvised borehole to determine the distance apart at which the detonators inclosed in each type of primer would detonate an explosive cartridge. It was found that the axially placed detonator detonated it at 18 in. distance, and the diagonally laid detonater at only 2 in. distance. "It would appear," says Mr. Christie, "that the diagonally placed detonator functioned only so long as it pointed toward some part of the explosive."

Commenting on the practice described, Arthur LaMotte, manager of the Du Pont company's technical section, says that although placing a primer in a borehole in a cylinder of inert material, with the end of the primer flush with the end of the cylinder, seems to have a certain amount of merit where inexpert or ill-disciplined miners are employed, its disadvantages would outweigh any advantages. The company's research men have found that the maximum effect of the detonator is developed where the entire detonator is buried in the explosive, with the closed end pointing in the direction of the bulk of the charge and lying as nearly as possible on the center axis of the priming cartridge. Experiments have proved that more complete detonation is obtained by this means than when the detonator is merely fired against the end of the cartridge of high explosives. Of course, some high explosives are so sensitive that very little difference will be noted whether the detonator is actually imbedded in the dynamite or only held against it, but the law holds, nevertheless, and even with explosives having satisfactory sensitiveness, better funes would undoubtedly be obtained if the entire force of the detonator were exerted on the explosive instead of being expended in shattering the inert cylinder.

Electrolytic Production of Thorium and Uranium

F. H. Driggs

Westinghouse Lamp Company, Bloomfield, N. J.

THE industrial production of such metals as aluminum, magnesium, beryllium, and the alkali- and alkaline-earth metals sodium, potassium, calcium, and barium, has been made possible only by the electrolysis of their fused salts. Such metals would probably exist only as museum specimens if any other metallurgical process had to be applied for their preparation.

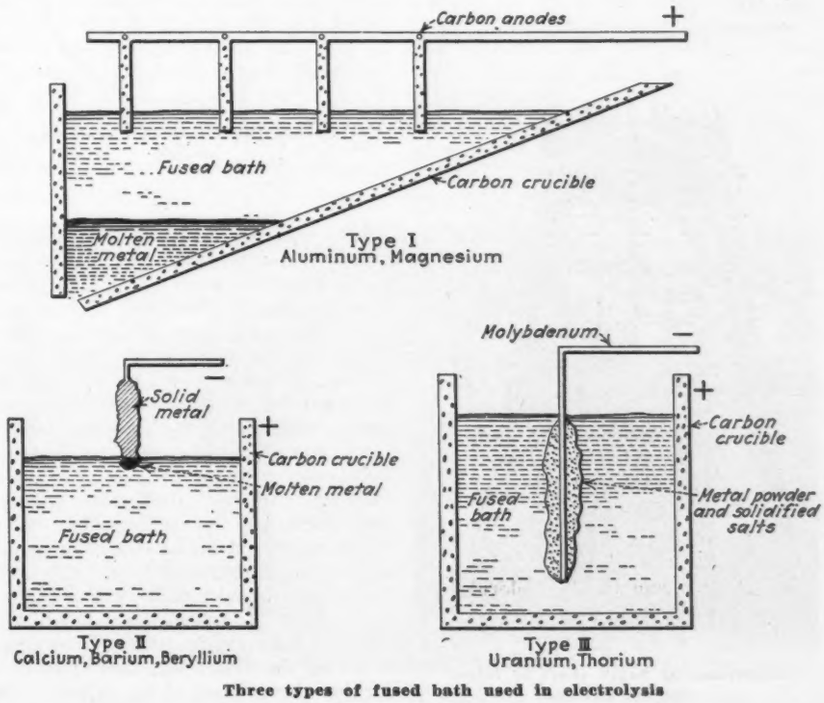
The electrolytic method has now been extended to include the preparation of the rare metals thorium and uranium in the Research Laboratories of the Westinghouse Lamp Company, at Bloomfield, N. J. In the preparation of metallic uranium, the raw material used is uranium nitrate. The metal is not made from this salt directly, however. It is first changed to potassium uranium fluoride, or "green salt." This is accomplished by placing a solution of uranium nitrate, potassium fluoride, hydrofluoric and formic acids in shallow wooden tubs and exposing the solution to sunlight or to a source of ultra-violet light. Through the agency of the ultra-violet rays the uranium nitrate is converted to the "green salt," which is recovered by filtration. This salt is then added to a molten bath of calcium and sodium chlorides and electrolyzed to metallic uranium, in a manner similar to the electrolysis of aluminum oxide to metallic aluminum in a cryolite bath. The preparation of metallic thorium is carried out in a similar manner, except that a thorium salt obtained from thorium nitrate is substituted for the "green salt."

However, there are certain fundamental differences in the process when applied to the preparation of these two metals. In the treatment of aluminum, magnesium, and the alkali metals, their melting points lie far below the boiling point of the fused bath from which they are produced. As a result, the molten metal is formed during the electrolysis in the crucible, from which it may be tapped from time to time. Even in the treatment of beryllium and calcium these metals first collect in the molten state at the cathode, where they solidify and are gradually raised from the bath in the form of a solid rod.

Neither of the methods described can be applied to the production of uranium or thorium, because their melting points are 1,690 deg. C. and 1,842 deg. C., respectively. Such extremely high operating temperatures are obviously not feasible. If, however, a fused bath containing salts of the above-named metals is operated at temperatures between 700 and 800 deg. C., the metal deposits upon a cathode suspended in the center of the bath, in the form of a loosely adhering powder. When this deposit has reached a thickness of about 1 in. it is withdrawn from the bath, a fresh cathode is inserted, and the electrolysis is continued. The accompanying diagrams illustrate the fundamental differences between the operation of the three types of fused baths. When scraped off, the deposit on the cathode consists of a spongy mass of metal interspersed with the calcium and sodium chloride from the bath. The metal is purified by leaching out these salts with water, washing, and drying in vacuo.

The next step is to transform this powder into a solid mass, from which it may be worked into the desired shapes. This is accomplished by either melting or sintering in a high vacuum. This is necessary because both metals react readily with almost all gases when heated. If a molten mass is desired the powder is pressed into a pellet and then placed in a thoria-lined crucible. Ordinary refractory crucibles—of alundum and magnesia for example—are unsuitable, because they react with the molten metal. The crucible is surrounded by tungsten coils connected to a high-frequency oscillator. The crucible is placed in a highly evacuated container and brought to the melting point by means of induction heating.

However, the metals under discussion need not be melted to make them workable. If a bar, made by pressing the metal powder under hydraulic pressure, is clamped between two terminals in an evacuated treating bottle it will conduct an electric current. The bar may thus be heated to a temperature slightly below its melting point, and, if held at this point for a few minutes, it will have the same properties as if it had been cast from the molten state.



Three types of fused bath used in electrolysis

Either uranium or thorium metal, after the heat-treatment described, may be cold-rolled, hammered, or drawn to almost any extent. Thus, both metals are now commercially available in the form of wire and sheet. Thorium is a very soft metal, extremely pure samples approaching lead in this respect. Uranium is of about the same hardness as a normalized steel (0.1 per cent). Both metals oxidize readily when exposed to the air, the bright metallic surface becoming covered with a layer of oxide. Both of these metals exhibit photo-electric properties, but are sensitive only to the violet or ultra-violet portion of the spectrum. This makes them particularly useful in the construction of cells for measuring the intensity of ultra-violet radiation from the sun or from ultra-violet lamps. Because of high atomic number, the total X radiation from targets made of these metals is higher than that from tungsten. Also, the characteristic K radiations are more penetrating, making them useful in deep-ray therapy. Both uranium and thorium are radioactive, and, as a result, tend to ionize the gas surrounding them, making it a conductor. This property is taken advantage of in constructing electrodes for gas-discharge devices where a low initial break-down voltage is desired.

The present capacity of the electrolytic cells for the manufacture of thorium is between 4 and 5 lb. per day, with production somewhat below that figure. The price of the metal depends largely upon the shape and sizes desired, but a basic price of about $75 per pound for the sintered metal is a fair estimate.

Up to the present time the total production of uranium has not exceeded three pounds. The prices for wire and sheet are calculated from a basic price of $900 per pound for the sintered metal. Inasmuch as the raw materials uranium nitrate and thorium nitrate, used in the production of these metals, are readily available in large amounts, the prices mentioned would diminish with increased production.

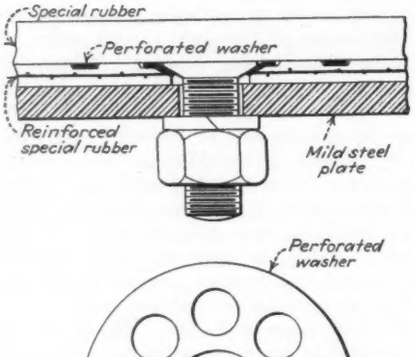
Special Rubber Linings for Skips

OWING to the caking of wet fine ore in the bottom of skips, Randfontein Estates Gold Mining Company, operating on the Witwatersrand, South Africa, found that as much as one-half to three-quarters of a ton of ore was being retained in each of the skips after a few hours of operation. In addition to the loss in tonnage hoisted that this accumulation in the skips occasioned, inconvenience was caused by spillage at the skip-loading pockets, where measured skip-loading methods are employed. This spillage was, of course, equal in amount to that of the ore retained in each skip when it was dumped at the skip bins.

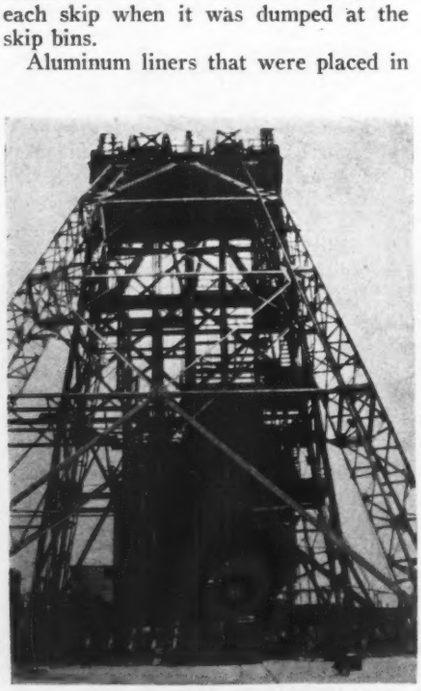
Aluminum liners that were placed in the bottom of the skip remedied the condition for a short time, but, as soon as they became scarred by the ore, they were no longer effective. Experiments were then made with a special rubber, known as Linatex. In the first test, a piece, 2 ft. square and 2 in. thick, which was fastened in the bottom of a skip, proved conclusively that this particularly "live" rubber would expand or "breathe" sufficiently to move the wet, fine material, when relieved of the superimposed load during the tipping operation. This slight movement imparted by the rubber to the fine ore caused it to leave the skip with the remainder of the ore.

A pad of the rubber, 2¼ in. thick and covering the entire bottom and about 8 in. up the sides, was then placed in a skip. Attachment of the rubber to the steel was effected by the use of a special bolt-and-washer device, which is shown in one of the accompanying illustrations. After more than 60 hours of hoisting, only 134 lb. of fine ore accumulated in the skip, whereas 1,407 lb. was retained in an unlined skip after only nine hours of operation. Using these figures as a basis for calculation, and assuming the skip makes 30 trips an hour, 170 tons more of ore is raised per nine-hour shift by the lined skip, as compared with the tonnage that can be hoisted by the unlined skip.

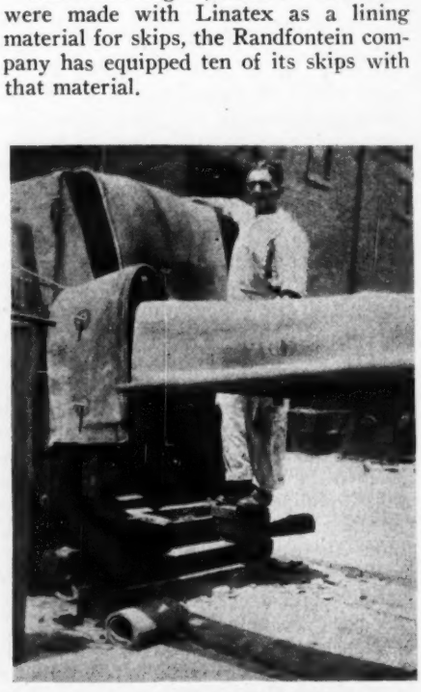
Since last August, when the first tests were made with Linatex as a lining material for skips, the Randfontein company has equipped ten of its skips with that material.



Special bolt-and-washer fastening device

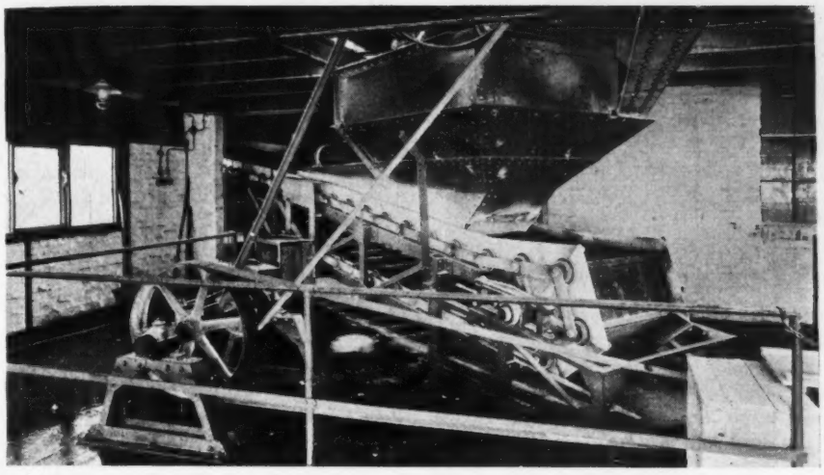


Headframe at South shaft of Randfontein Estates



Fitting special rubber lining in a six-ton skip

European Practice in Milling Potash Minerals



Apron conveyor transferring potash mineral from the car dumper to the hammer mill

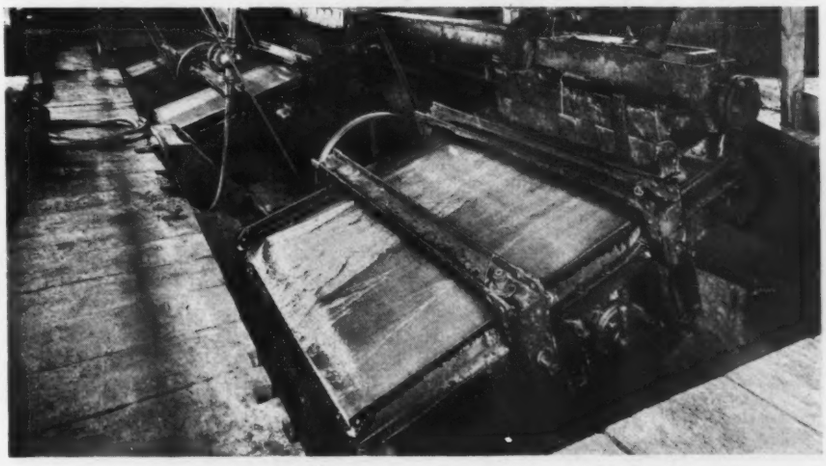
AFTER the War the German potash producers found themselves facing foreign competition, especially from the plants in Alsace. To meet this condition the plants treating low-grade potash were closed down and their quotas—their share in the syndicate's production—were distributed among plants treating a product of higher grade. This arrangement, which effected a better economy in operation, necessitated a higher output of crushing and grinding plants and auxiliary equipment. Formerly a tonnage of 60 to 80 metric tons per hour had been called for. This had to be raised to 100 to 120 tons per hour, or more. The increased demand on the equipment created new problems for the designers and manufacturers of crushing and grinding machinery for the potash industry.

The new grinding plant of Consolidierten Alkaliwerke, Westeregeln, was designed and built by Fried. Krupp Grusonwerk. Although only a limited space was available, a suitable plant with well-arranged conveying and screening equipment was erected. No interruption in the feed to the grinding plant already in operation was allowed, so the car dumper could not be placed over the new grinding plant. A two-car dumper was therefore installed near the shaft, from which point the unloaded material is transferred to the grinding plant with an apron conveyor and dumped on a grizzly which retains material above 20 to 25 mm. ($\frac{3}{4}$ to 1 in.), compared with an 80-mm. ($3\frac{1}{8}$-in.) grizzly opening used in former practice. The oversize goes to a double-hammer mill, and the undersize is bypassed to a fine-grinding plant for further treatment. Although the hammer mill is capable of reducing large lumps to the desired size of 5 mm. ($\frac{7}{16}$ in.), the smaller grizzly opening is used to save it from overloading. If no fine grinding of the material is required, screens with openings according to specifications, generally 10 to 15 mm. ($\frac{1}{4}$ to $\frac{5}{8}$ in.), are used in connection with the grizzly, which is so constructed that it may be set for the smaller particle size.

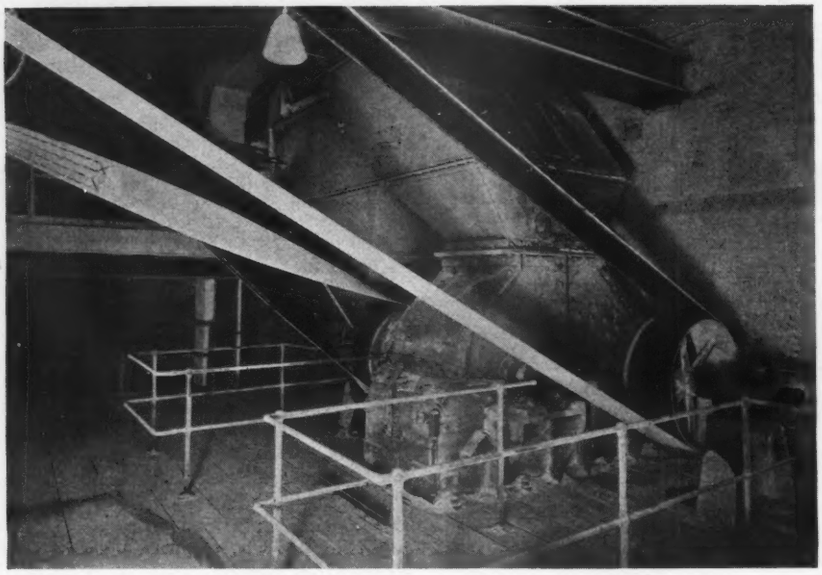
In the double-hammer mill the material is reduced to about 5 mm. ($\frac{1}{4}$ in.) in a single operation. The hammers do not hit the pieces of crude salt resting on the grizzly, but the shafts turn in such a manner that the pieces are hit from below, as they drop into the mill. Lumps not shattered by the blow are then hurled against the housing of the mill, which has a replaceable lining. As the material is crushed in the free fall against the hammers, or by hitting the housing, and not against an underlying surface, it breaks without being ground too finely. This is of special importance in regard to further treatment. In the mill at Hadmersleben the hammers, both of which are driven by belt from a main shaft, swing in a circle of 1,000 mm. (40 in.) diameter. The mill is designed for a capacity of 120 tons per hour. Mills with a hammer diameter of 1,300 mm. (51 in.) and an hourly output of 250 tons have also been built.

The hammer mill is little affected by tramp iron. Pieces of iron, such as screws, rail spikes, tools, and even car wheels, are often found in the feed. When a piece of iron gets into the mill, which may immediately be detected by the noise, the grizzly is first set so that the feed is discontinued. The hammers will then sling the piece out of the mill and up on the grizzly, where it may be removed. This procedure has been adopted by all plants using this type of mill, and no breakage of machinery has occurred, the only damage done being some bent grizzly bars, which are easily replaced.

The crushed material falls on a grizzly placed in the lower part of the housing, the opening of which may be



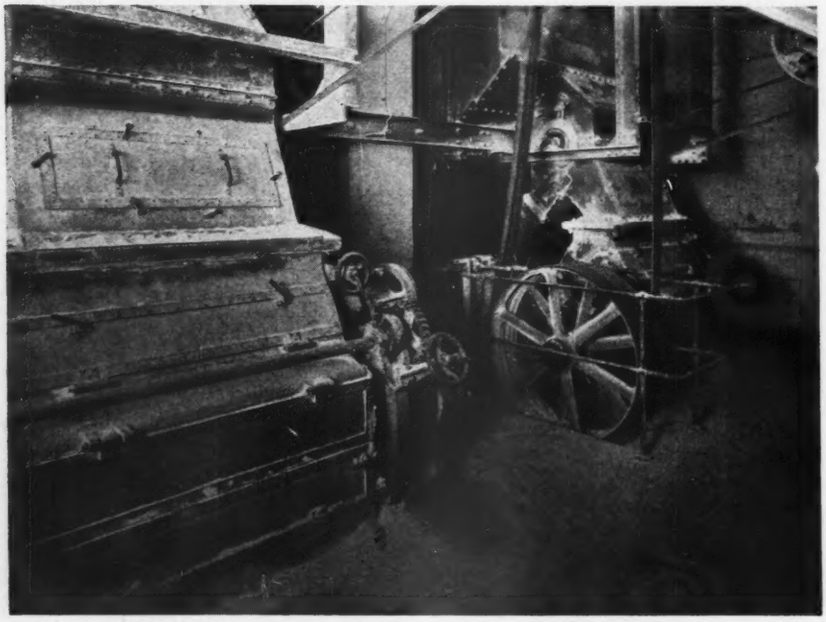
Inclosed vibrating screens classify the discharge from the hammer mill



A reduction from 25 to 5 mm. is effected in these hammer mills

set for any desired size of particle. If the crude ore has to be treated further in the factory, a size of 5 to 6 mm. ($\frac{1}{4}$ in.) is required, and finer grinding is then not necessary. Undersize from the grizzly and discharge from the hammer mill are then conveyed directly to a bucket elevator placed at the end of the grinding plant. A product that it shipped directly after crushing, however, must be ground finer, generally to 3- to 4-mm. size ($\frac{1}{8}$ to $\frac{5}{16}$ in.), in which case the discharge from the hammer mill must be screened and the oversize ground in a fine-grinding mill. For this purpose the undersize from the grizzly and the discharge from the hammer mill are first conveyed to a screening plant, by changing a flap valve in the discharge pipe under the hammer mill.

Revolving screens capable of handling 120 tons per hour would be of such large dimensions that the space available was entirely inadequate. For this reason vibrating screens were selected, of a type commonly used in potash plants. On account of their large capacity, two screens with 1.6 x 1.6 m. active surface ($5\frac{1}{3}$ x $5\frac{1}{3}$ ft.) were found sufficient to handle the output of the hammer mill. Undersize falls into the bucket elevator. Oversize is conveyed to rolls, where it is ground to the desired fineness. It is then likewise discharged to the bucket elevator. A strong magnetic trommel is placed between the screens and the roll to remove small pieces of iron broken up in the hammer mill, which otherwise would enter the leaching plant or contaminate the shipping product.



Inclosed rolls for fine grinding of potash mineral

No picture of the screens installed at Hadmersleben can be presented, as they are completely inclosed to protect them from dust made in grinding hard salts and sylvinite. But a battery of screens used in another potash plant for wet screening, to separate crushed material from leach solution, is shown herewith. The entire installation at Hadmersleben has been arranged in a manner that allows great flexibility in case of irregular operating conditions, as for instance when four cars from the shaft are all dumped at the same time. The designed capacity of 120 tons per hour has been reached without difficulty, and even 160 tons per hour has been reduced to 6 mm. ($\frac{1}{4}$ in.).

Conditions in the potash plants of Alsace and Spain differ from those in Germany. Hammer mills are not so well adapted in these plants. Jaw breakers and crushing rolls have proved more satisfactory. This applies particularly to the schistose deposits of Alsace. The pieces of slate should not be crushed, but must be removed as far as possible by screening. In view of this fact, special importance is attached to the design of toothed rolls and the kind of fluting employed. Crushing units have been installed in Alsatian plants with capacities up to 120 tons per hour.

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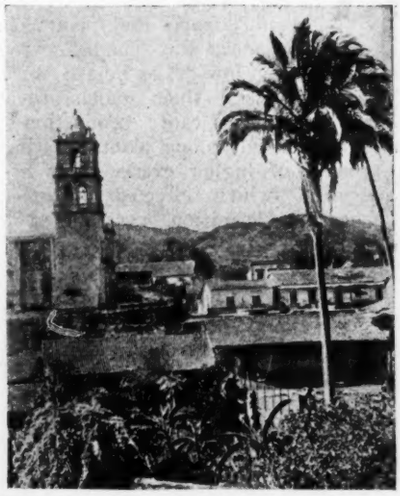
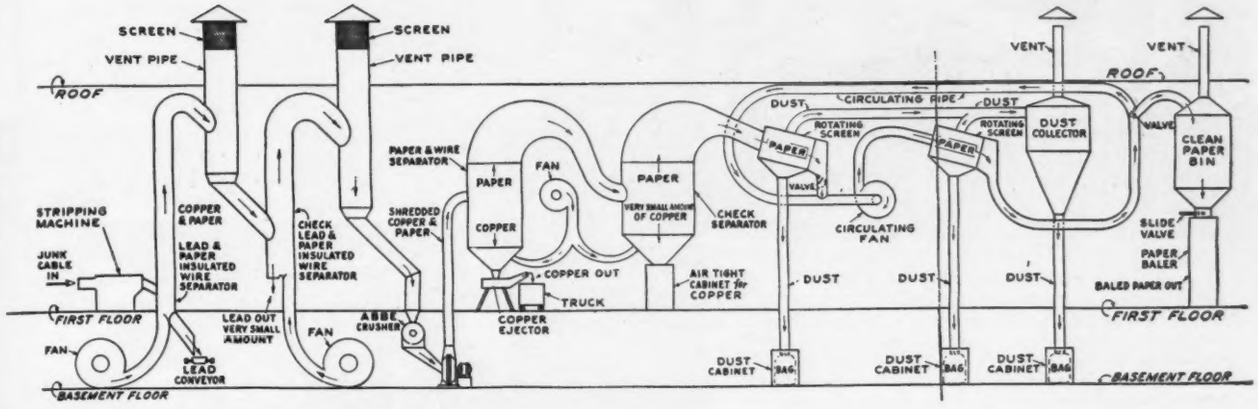
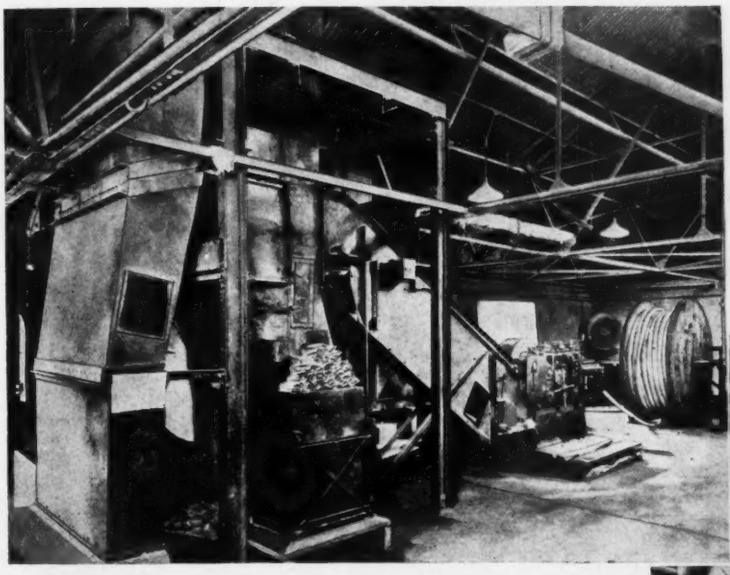


A Relic of Early Mining Operations

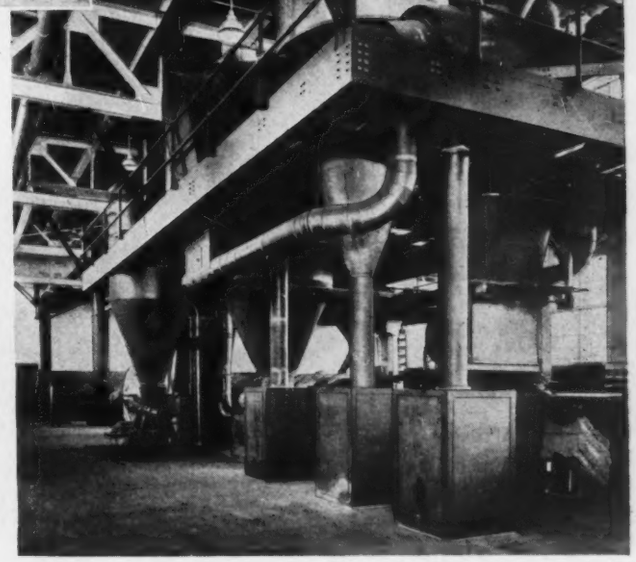
The accompanying picture shows the town of Copala, State of Sinaloa, Mexico. The old church at the left is said to have been erected through the generosity of the Duke of Panuco, who worked the silver mines in the Panuco and Copala sections about 150 to 175 years ago, according to Roy W. Moore, general manager of United Eastern Mining. Mr. Moore's company is now exploring at depth properties that were formerly worked at the surface. Flotation will be used in concentrating preparatory to their reduction to metal.

Salvaging Lead and Copper in the Telephone Industry

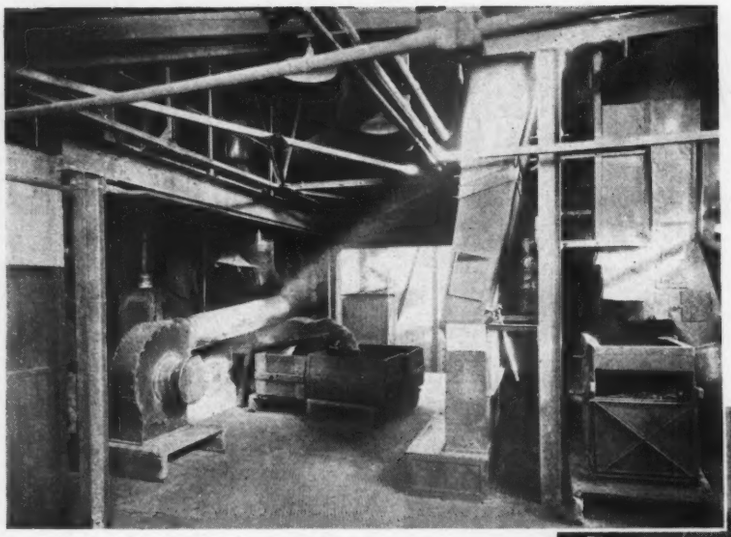




The telephone industry requires that materials of exacting specifications be used in manufacturing telephone equipment. Illustrations are herewith presented that show how the Western Electric Company is maintaining these materials within the Bell System for re-use and thereby is conserving a considerable portion of the nation's natural resources. The operations shown cover the reclamation of lead-covered telephone cable and secondary copper. Telephone cables that have worn out or broken from use or exposure to the weather are returned to the Hawthorne or Kearny works of the Western Electric Company. Above is a schematic diagram showing the method for reclaiming lead, copper, and paper from the lead-covered cable.

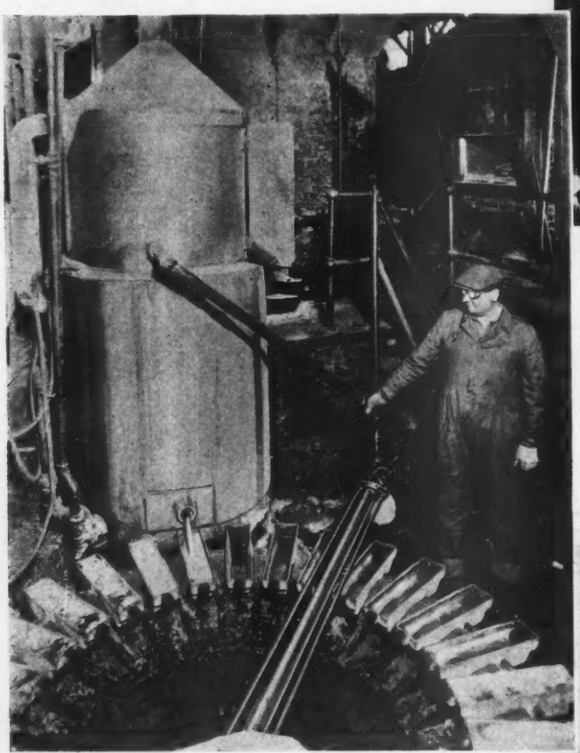


Reels containing cable weigh as much as 6,000 lb. and, after being unloaded from a freight car, are handled by specially designed trucks operated by either hand or electric power. The cable is fed into a stripping machine where the sheath is slit on opposite sides of the cable by two revolving circular knives. Both the core and sheath are then cut into 6-in. lengths and are discharged into an inclosed upward current of air. This air carries away the core, but allows the lead sheath to fall. Above is the Hawthorne installation, where the lead sheath is discharged into a truck. After leaving the stripping machine the cable core, consisting of paper-insulated copper wire, is cut into approximately 2-in. lengths, which are discharged into chambers, where the paper is blown free from the copper wires. At the right is the installation of the pneumatic separators at the Kearny works.



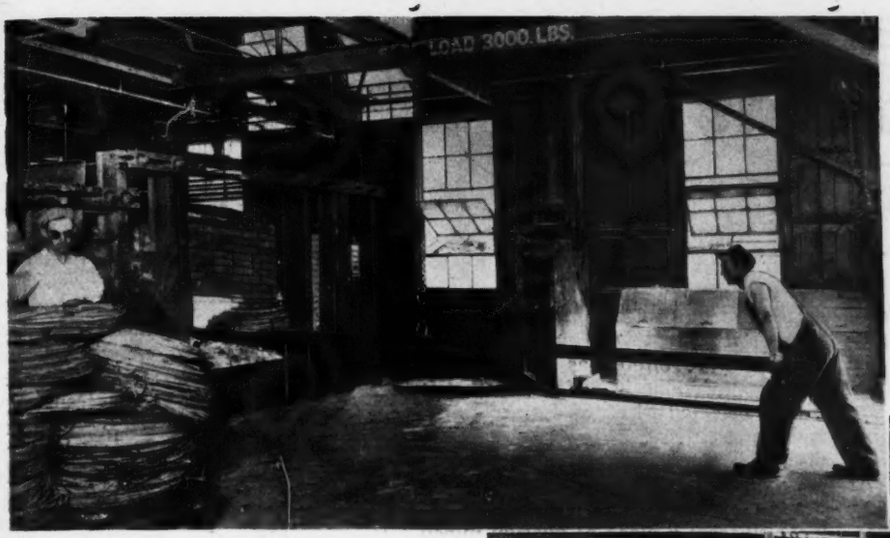
The copper wire is ejected after it has settled against the upward current of air in the pneumatic separators, as shown at the left. The paper that enveloped the copper wire is blown through several chambers for "air-washing" to eliminate dust. It finally settles into a chamber, from which it is removed and baled. Cable so tangled that it cannot be economically handled in the stripping machine is cut into lengths and charged into a furnace, where the lead is sweated from the cable and the paper is burned off the copper wire.

The illustration at the right shows burned copper wire being baled after paper ashes have been removed by air blowing. Copper which has been reclaimed by the sweating method is not so valuable as the copper obtained by the pneumatic separating process, owing, primarily, to its higher lead content.

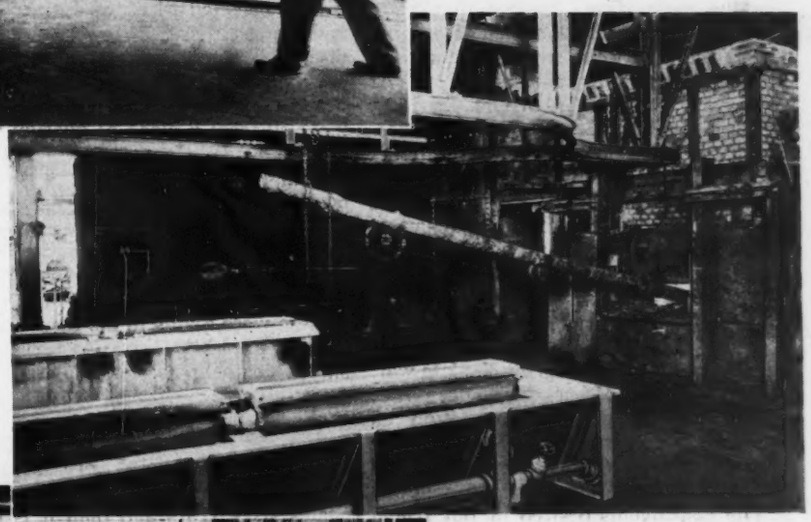


Lead alloy obtained from the sweating furnaces and from the stripping machine is cast into 100-lb. pigs. At the left is the installation at the Hawthorne works, where a casting wheel is used. In the upper right corner can be seen the grate of one of the "Dutch-oven" type of sweating furnaces.

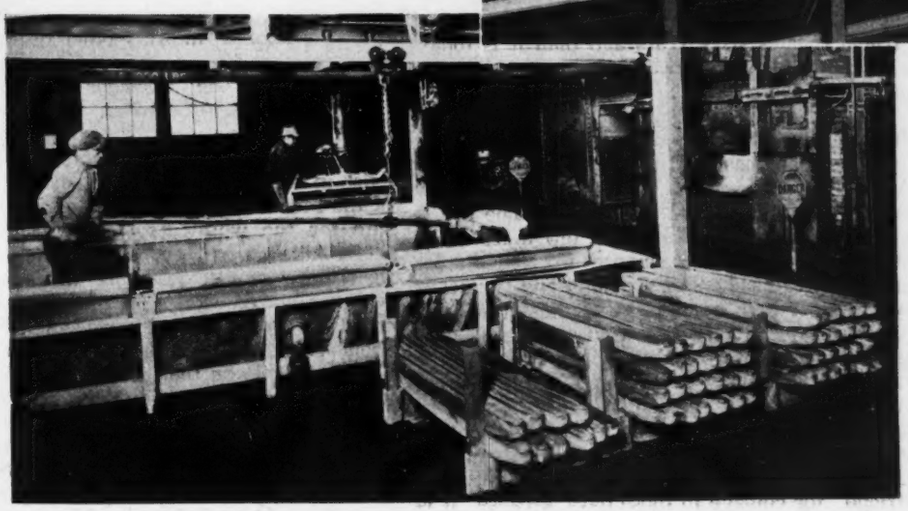
Stacks of lead pigs are taken from the stacking machine to and from storage with a special electric truck, as shown at the right.



Bell System secondary copper line wire and suitable copper wire scrapped from various manufacturing operations are delivered to a reverberatory furnace at the Hawthorne works. Secondary copper is being charged into the reverberatory furnace at the left.

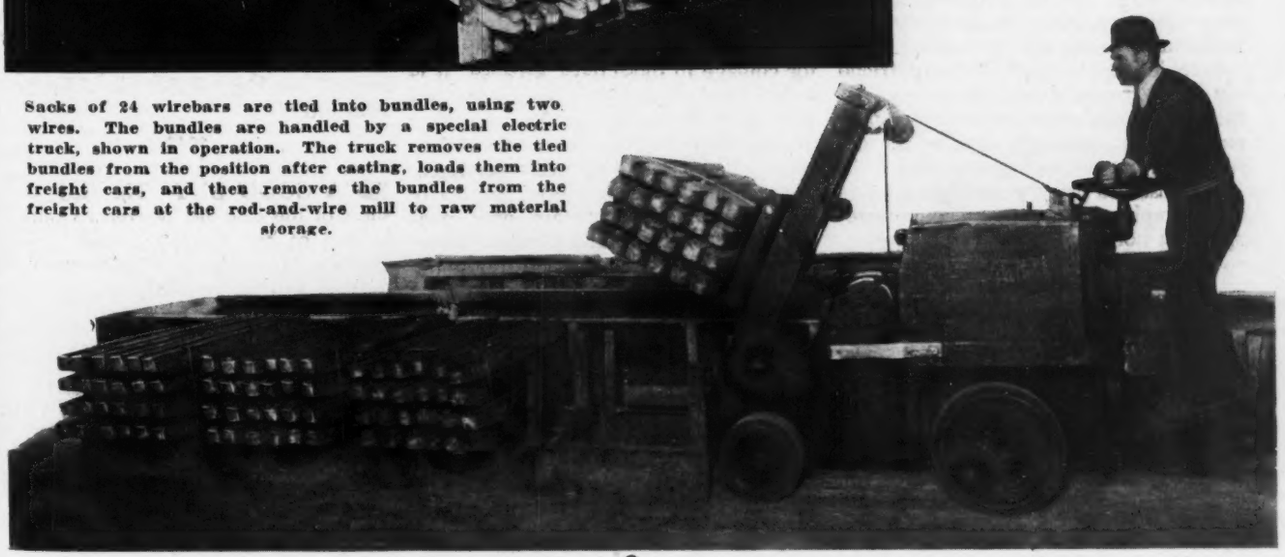


As in all copper-refining furnaces, the excess oxygen is burned out of the molten copper with poles of wood. From ten to twenty poles of the size shown at the right are required to pole a single heat.



Copper is cast, by hand pouring, into 250-lb. wirebars, 60 in. long, of approximately 4x4-in. cross-section. In the background of the illustration at the left can be seen a newly developed machine for removing the cooled wirebars from the quenching water tanks. The illustration also shows the manner of stacking the bars into stacks of 24 bars each.

Sacks of 24 wirebars are tied into bundles, using two wires. The bundles are handled by a special electric truck, shown in operation. The truck removes the tied bundles from the position after casting, loads them into freight cars, and then removes the bundles from the freight cars at the rod-and-wire mill to raw material storage.



SIXTY YEARS AGO

1870-1930

☞INTELLIGENCE WANTED — Apparently requests for the names of the manufacturers of witch sticks, dowsing rods, doodlebugs, or whatever one wishes to call them, were not unknown in the early days; in fact they were probably more common then if one accepts the theory that the human race is gradually becoming more intelligent. At any rate, the *E.&M.J.* of Oct. 19, 1869, contained a letter from a Georgia correspondent as follows: "I desire to get an instrument which will detect the location of gold deposits, and also places where gold has been buried. I have a mine on my place and would like to get the most improved instrument which will answer my purposes for that, and also to find the spot where a friend of mine buried some gold, the spot having been defaced by the army during the late war. P. S. Probably Messrs. ——— & Co. could give the desired information, as they are cognizant of the like, being connected with the Patent Office."

Dr. Raymond answered as follows: "The instruments desired by our friend are no longer to be had. They have gone out of the market—went out, in fact, when spelling books came in. Even Messrs. ——— & Co., though they have patented everything else under the sun, have never fathered one. As the next best thing in the premises, we have consulted, through a medium, the spirit of Dominus Doctissimus Aureolus Philippus Paracelsus Theophrastus Bombastes von Hohenheim, but we regret to say that the old gentleman, having been dead 300 years, has degenerated into a very ordinary person. He replies, just as any one, not dead at all, might have done: If you have a gold mine on your property, there is probably gold in the mine—(you are too positive there, venerable sage!)—and if your friend buried a treasure, and the army 'defaced the spot,' then your friend may expect to recognize the spot by the defacement, but not to find any gold in it. We refused to pay the medium for this trivial reply, and we charge our correspondent nothing for our trouble."

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☞THE CARDIFF GIANT—This, one of the most notable of the hoaxes that gave our grandfathers so much pleasurable excitement, when life was simpler than it is now, was the subject of an editional in the same issue of the *E.&M.J.* mentioned above, perhaps for the reason that it was a new use for gypsum. On Oct. 16, 1869, a rudely cut statue of a giant man, asleep, was unearthed in the bed of Onondaga Creek, near Cardiff, in New York State. Many theories were offered as to its origin and antiquity, one of which was that it was a petrified giant of former times, and scientific societies were not above discussing the matter. After the discovery had been exploited to the full, it developed that the giant figure was modeled from a block of gypsum mined at Fort Dodge, Iowa, and George Hall, of Binghamton, N. Y., confessed to the fraud. His object was to discredit belief in the giants mentioned in Genesis, vi, 4, which, in case any of our readers passed lightly over that particular chapter when they read the Scriptures, says: "There were giants in the earth in those days." Evidently, Mr. Hall wished to show just how they might have come there.

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☞NICKEL—Nickel ore seems to have been more common in the United States sixty years ago than it is today, when, if one wants a specimen, it has to be shipped in from Canada. In 1869 "a mine, the ore of which carries a workable proportion of nickel, has lately been opened on the banks of the Hudson River, some 43 miles north of New York, at 'Anthony's Nose.' The ore is taken to the landing a few miles above Peekskill and shipped to Newark for treatment. 'Pennsylvania and Connecticut both contain,' says the New York *Times*, 'very rich veins of nickel, only partially worked, however, owing to the difficulty of separating the metal from the ore. English nickel can now be bought in this market at $1.25 (gold) per pound, and American nickel at about the same price.'" Nickel was not liked for coinage in those days, because "it is so hard and sharp that it breaks the dies with great frequency, to the annoyance of the people at the mint." Doubtless better dies have now been perfected, though our five-cent pieces, popularly known as nickels, contain only one-quarter of that metal, the other three-quarters being copper, and the alloy would not be so hard on dies as pure nickel. Ten years or so ago, the Canadian government decided that, as nickel was primarily a Canadian metal, their five-cent pieces, instead of being made of silver as theretofore, should be made like the American five-cent pieces, only of pure nickel, so it is now a pure nickel "nickel," with King George on one side and the maple leaf on the other, that one gets when one goes to Montreal. The Canadian "nickel" is better looking than the American "nickel": containing no copper, it always retains its bright silvery appearance, without any coppery tinge that our nickels sometimes acquire after hard usage. Sixty years ago, electro-plating of nickel was just beginning to achieve commercial importance, as a substitute for silver. The price of nickel, it will be noted, was then four times what it is now. The Ontario deposits, which were discovered and developed in the 'eighties, doubtless brought the price down rapidly. Sizable deposits of nickel have also been reported in other parts of the Dominion, but so far have not passed the prospect stage. A few small deposits known to exist in the United States have not been attractive enough for commercial development in recent years. It would take a pretty rich deposit to compete with either the Creighton or Frood, two of the world's greatest metal mines.

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☞WHERE MINING WAS ACTIVE—Most of the mining news in 1870 came from California and Nevada. In Arizona, the Indians were too hostile to lend much encouragement to prospecting. Some parties came down to that state from White Pine, Nev., but went back, declaring that the evidence of mineral wealth was more abundant in eastern Nevada, and "in every other respect it is incomparably ahead of any part of Arizona." The Mormons in Utah seem to have been just about as popular as the Indians in Arizona: "Both placer and vein deposits of the precious metals exist in this territory, but the hostility of the Mormons having rendered it unsafe for the whites [sic] to prospect there, but little has been effected toward their development." Mining in Idaho was not active, except in the Owyhee country. In Montana the placers were about exhausted, but "the business of vein mining is on the increase, a great many quartz mills having been put up and run with about the same average results as in California. There being many advantages for prosecuting this business, it promises to become both permanent and profitable in Montana." And did.

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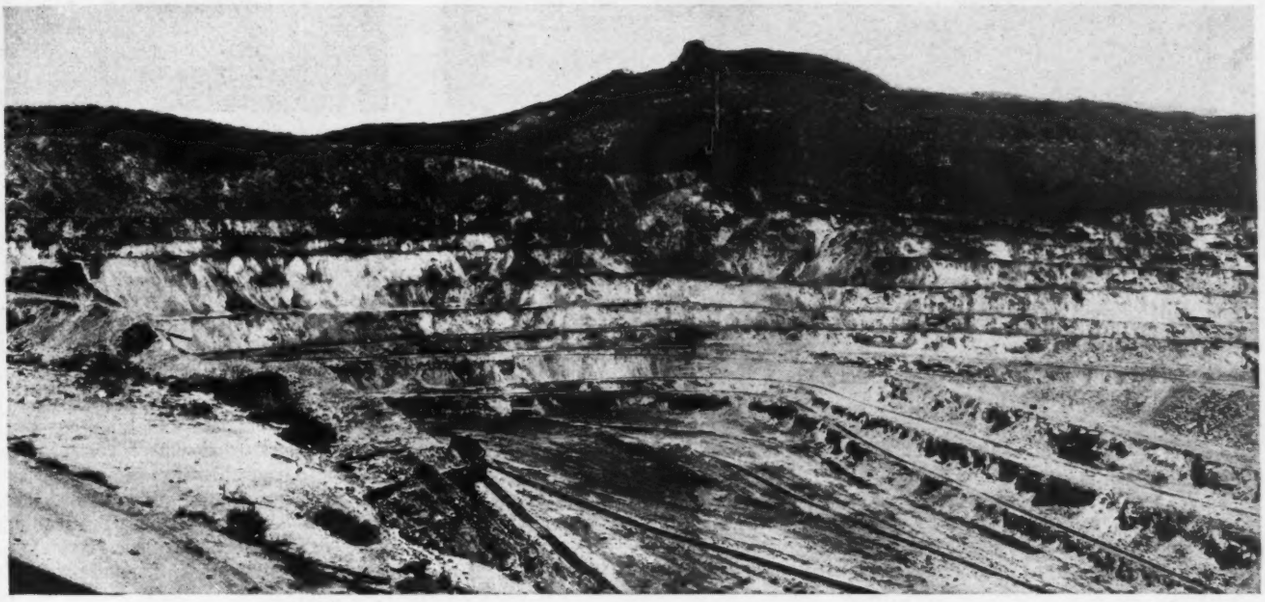
☞A GOOD BUY—The Red Jacket shaft of the Calumet & Hecla Company is one of the world's famous mining shafts. It is almost a mile deep, the deepest productive shaft on the continent, and all of the ore from Calumet & Hecla's conglomerate mine is hoisted through it. If any one is interested to know how much this property was worth sixty years ago, the answer may be found in the *E.&M.J.* of Nov. 30, 1869: "Messrs. Hulbert have sold their Red Jacket location to the Hecla Mining Company for $112,500."

E. H. R.

Mining and Metallurgical Developments in Arizona



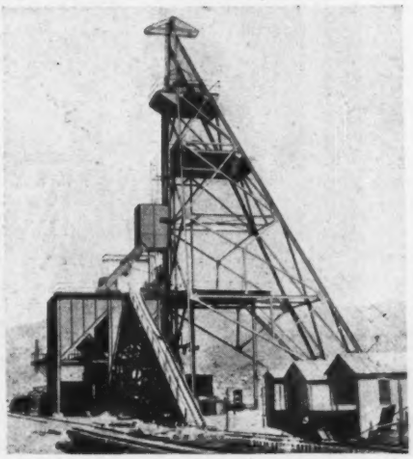
Chino open pit, Nevada Consolidated Copper Company, Santa Rita, N. M.

George J. Young

Associate Editor

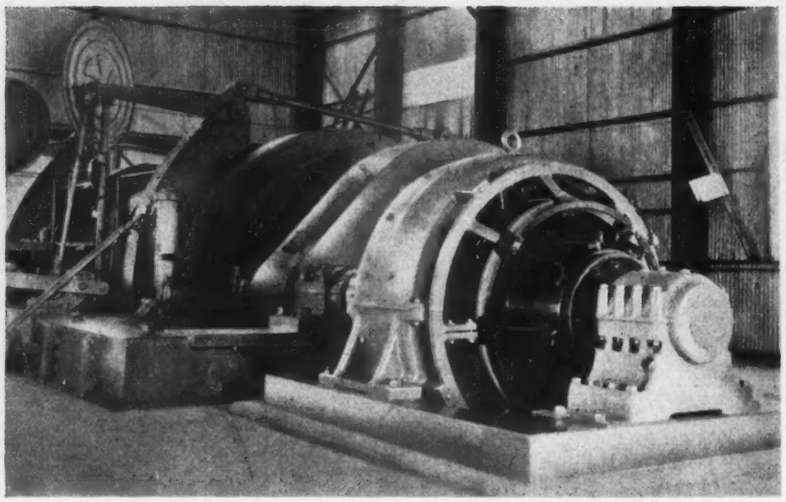
LATE in April, I visited Ajo, Bisbee, and Douglas, Ariz.; Santa Rita, N. M.; and Morenci and Bagdad, Ariz. Excepting Bagdad, which is in its pioneer stages, operations at all of these copper-producing centers have been curtailed upon a basis of approximately 60 per cent of normal.

At Ajo, the New Cornelia property of the Calumet & Arizona Mining Company has practically completed its year's program of construction. The major features of this new work are a three-unit addition to the five-unit sulphide mill, making eight units of a maximum capacity of 15,000 to 16,000 tons per day; the lengthening of Marcy rod mills to 15 ft. and installation of larger classifiers; re-equipment of the flotation section with MacIntosh cells; construction of a 400-ton experimental mill unit; and the reorganization of the crushing circuit and rolls, the last named being in closed circuit with a screening plant establishing a maximum product size of about 4 mesh. Bin capacity was increased to 46,000 tons and the belt conveyor system was reconstructed to provide for the use of the coarse-crushing equipment for carbonate ores as an auxiliary. A complete dust-collecting system has been installed and a 275-ft. diameter tailing settling tank has been completed. Steel and reinforced concrete of the most substantial construction were used. A new 7,500-kw. turbine, condenser, and accessories were installed in the power plant. Three steam shovels and seven locomotives were purchased. Compressor house and sharpening shop were removed to a more convenient location near the open pit. Water development was extended at well No. 1. Ore exploration is being continued by diamond drilling and substantial tonnages have been added to ore reserves. With its leaching plant, which is operated upon the basis of 3,000 tons per day, and its sulphide mill, New Cornelia has treatment capacity of almost 20,000 tons per day. Its large sulphide ore reserves insure a substantial life and the modern plant promises excellent cost records.

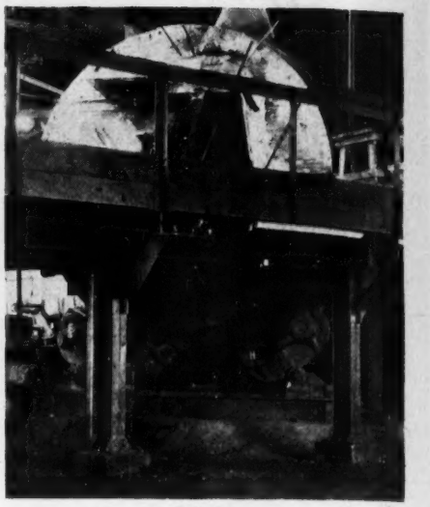


Campbell shaft of Calumet & Arizona near Warren, Ariz.

At Bisbee, glory-hole mining is well under way at the Sacramento open pit of the Phelps Dodge Corporation, and this source, together with underground mining, supplies the ore going to the



Electric hoist at Campbell shaft, Calumet & Arizona



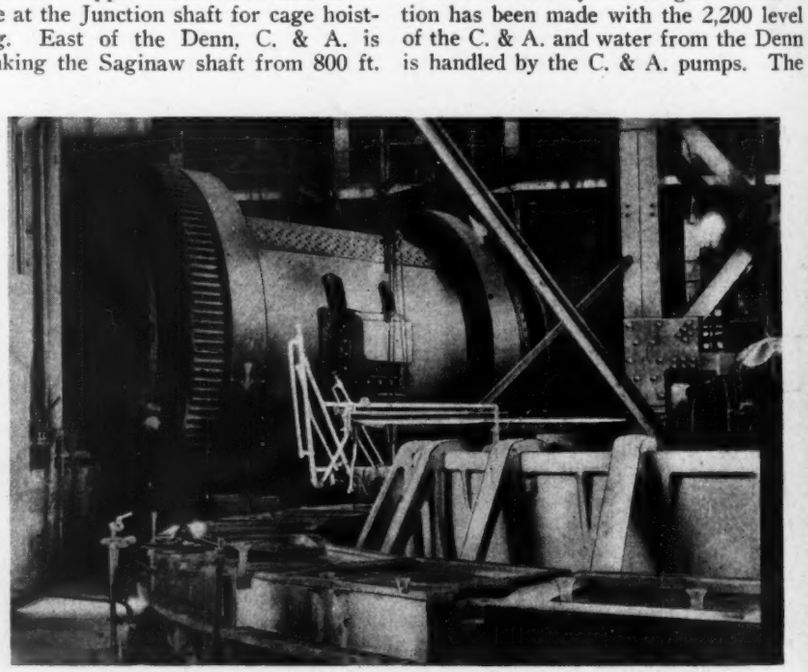
Revolving reducing and refining furnace, Calumet & Arizona smelter

Warren concentrator, the capacity of which has been increased to 5,000 tons by remodeling, although when grinding to 75 per cent through 200 mesh, capacity is reduced to 4,500 tons per day. The Warren shaft has been shut down, but diamond-drill exploration is under way. A water pocket was cut on the drift from the Warren shaft, and the estimated flow, 6,000 to 9,000 g.p.m., being in excess of the pumping capacity of 3,500 g.p.m. at the C. & C. shaft, the bulkhead door was closed and it will be some time before the area is drained and opened again. However, the striking of a large water pocket is viewed as a favorable indication of ore. Although no new orebodies have been discovered, the Copper Queen Branch has developed favorable extensions to known orebodies and reserves of limestone and porphyry ores are higher than for many years.

Probably the most interesting of the Copper Queen operations is the steady progress made in heap leaching. Leaching was started on two low-grade ore dumps in April, 1927, and to March, 1930, total copper extracted was 27,405,274 lb., or 50.35 per cent of the original total contained in the heaps, according to O. E. Simmons, foreman of leaching operations. In the latter part of 1929, leaching operations were started upon a 9,089,550-ton waste rock dump, averaging 0.26 per cent copper, and to March 1, 1930, extraction totaled 4,057,842 lb. As a consequence, other waste rock dumps are being prepared for leaching, and it is planned to leach the Sacramento open pit when the minable ore has been removed. The significance of this extensive heap-leaching at Bisbee is not appreciated as much as it should be.

Plant improvements have been made by the Calumet & Arizona Mining Company at Lowell. A steam power unit consisting of two 725-hp. Walsh and Wagner boilers to operate at 400-lb. pressure and 200-deg. superheat, and a 3,750-kva. turbo-generator, together with accessories and cooling tower, all of latest design, have been completed and are about to be turned over to service. Two Sullivan angle-compound compressors, of 4,400 cu.ft. capacity each, have been erected and a third unit now in operation in another part of the plant is to be moved to the power house. Steam under reduced pressure and desuperheated is to be supplied to the Nordberg steam hoist at the Junction shaft. The Campbell shaft is being concreted to the 2,340 level. An Allis-Chalmers electrically operated hoist has been installed at this shaft. Drums are 10-ft. in diameter by 7½-ft. face; drive is single-gear reduction and 1,350-hp. d.c. motor. Direct current is supplied by a flywheel motor-generator set: 1,000-hp. motor, 1,250-kw. generator, and 31-ton flywheel. A smaller hoisting unit of this same type was erected and is in use at the Junction shaft for cage hoisting. East of the Denn, C. & A. is sinking the Saginaw shaft from 800 ft. to the 1,800 level, and this shaft will be used as a ventilation upcast. During 1929, total footage of development was 62,939 ft., and ore shipped was 593,940 tons averaging 5.11 per cent copper.

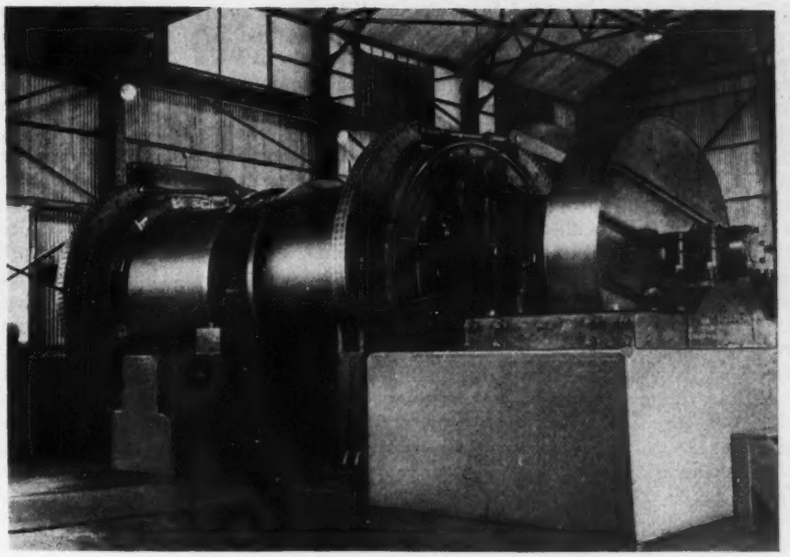
Since I was last at the Denn mine a new hoisting plant has been installed. A double-drum Nordberg hoist driven through single-reduction gears by a 600-hp. d.c. motor and supplied by a motor-generator flywheel set (550-hp. Westinghouse induction motor, 600 kw., d.c. generator, and 20-ton flywheel) serves the shaft. A duplex Sullivan and a belt-driven Imperial Type-10 compressor supply the present compressed-air requirements. The deepest level served by the shaft is the 2,200, and at this horizon there are interesting exploration possibilities, as several orebodies have been cut by workings. Connection has been made with the 2,200 level of the C. & A. and water from the Denn is handled by the C. & A. pumps. The



Casting wheel and refining furnace, Calumet & Arizona smelter, Douglas Ariz.

Denn is a mine in the making. During 1929 over 9,000 ft. of winzes, drifts, and raises were driven and 106,310 tons of ore was hoisted. Gross value of the production, including that of the Shattuck mine, was $2,340,146.

The proposed consolidation of the Calumet & Arizona with the Phelps Dodge Corporation was generally discussed, and, although some regretted the possibility, as near as such opinion could be evaluated by an outsider, the consolidation is considered to be the natural outcome of present conditions. The retirement of Walter Douglas and the appointment of L. S. Cates to the presidency of the Phelps Dodge Corporation excited considerable gossip and surprise, but both the retirement and appointment are happenings that are to be expected in the ordinary course of events. Walter Douglas passes over to his successor a splendid property with a commendable history, and L. S. Cates brings to his new field a wealth of mining, operating, and financial experience which is assurance to the stockholders that their interests will be ably administered.



Electrically operated hoist at Denn shaft, Lowell, Ariz.

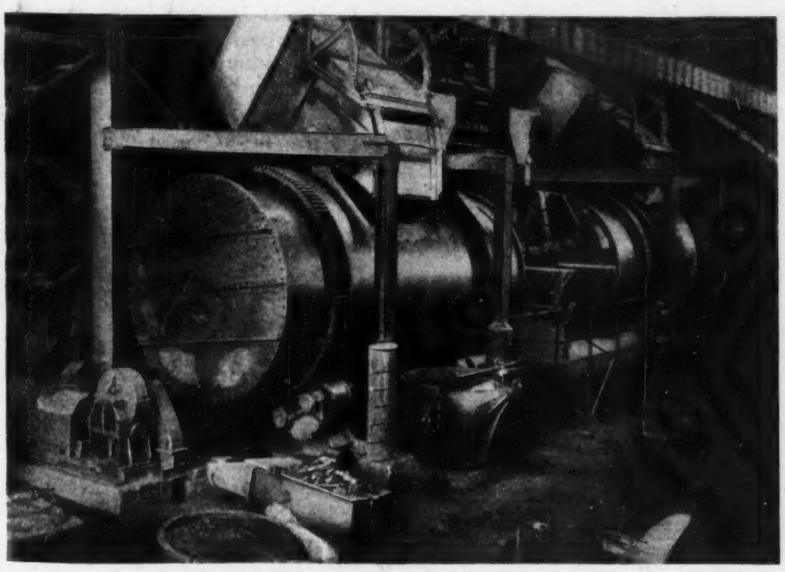
Smelters at Douglas

Copper Queen's smelter, at Douglas, has its two-reverberatory smelting unit in successful operation. The new anode casting installation is in full operation, but the lead smelter has been temporarily shut down. The anode installation consists of two 15-ton end-tilted furnaces (oil fired) in which the blister copper is oxidized, and a third furnace of the same size used for reducing and pouring. At the present rate of production only two furnaces are in use—one for oxidizing and one for reducing. The reducing furnace is mounted on a traveling carriage by which it is moved down the line of molds and, by means of the usual spoon, pouring is closely controlled. The molds (58 in number) are supported in a line upon a structural steel frame and can be accurately leveled. A compressed-air cylinder on each mold detaches and lifts the anode sufficiently to enable the overhead crane to pick it up, and it is then transferred to cooling stands. Electric trucks are used for gathering the stacked anodes and transferring them to the storage posts, from which, after trimming and inspection, they are loaded, on day shift, into box cars for transportation to El Paso. Cooling of the hot anodes in the molds is effected by a small stream of water which plays over the surface of the anode. The installation is excellent and reflects great credit upon H. H. Stout, who has evidently removed a number of difficulties in the securing of satisfactory anodes of uniform weight.

The Cole bedding and reclaiming system, consisting of five 11,500-ton reinforced-concrete bins and conveyor runs, is rapidly nearing completion. A sample mill and a crushing unit, consisting of breaker, rolls, and Hum-mer screens, are well advanced.

At the C. & A. smelter four new ten-hearth Herreshoff roasting furnaces are being erected and are to be used for acid plant work. Three Peirce-Smith converters, 13x30 ft., have been installed, and three reverberatory smelting furnaces, 26 ft. wide, are planned but as yet are not constructed. An anode casting plant is now in service. It consists of two revolving oil-fired furnaces, 13x20 ft., and a Walker casting wheel of 22 molds. The furnaces are oil fired and charges of blister copper are oxidized and reduced.

Preliminary steps are being taken to secure agreements with copper-producing companies of southeastern Arizona to use gas fuel to be supplied by pipe lines from West Texas and New Mexico. The use of this new fuel is being seriously considered. El Paso, Douglas, Bisbee, Morenci, Miami, and even Ajo are possible points where natural gas may be used.



New converters at Calumet & Arizona smelter, Douglas, Ariz.

The Chino property of the Nevada Consolidated Copper Company at Santa Rita, N. M., is an open-pit mine of great size. Most of the power shovels have been electrified and other equipment is being improved. A man shaft is now being concreted to the 660 level and will be equipped with an electrically operated elevator. The ore shaft has been concreted, and although underground mining belongs to the distant future, exploration workings are being extended to new ground and will develop large tonnages that have been disclosed by drilling south of the present pit. Both the mill and power plant at Hurley have been greatly improved. The fine-crushing layout consists of three Symons cone crushers, steel apron plate feeders,

and Hum-mer screens, ¾- and ½-in. openings, which bypass undersize material. The cone crusher product plus oversize, between ½- and ¾-in. screens, are elevated to surge bins, from which roll feeders deliver to 4x5 Hum-mer screens, ½-in. opening, oversize going to three 72x20-in.-Garfield rolls, the product from which is received by bucket elevators and returned to the surge bins. Undersize is conveyed to the fine-ore bins. The mill feed is through 4 mesh. Fine crushing is by primary rod mills (7x10 ft.), all of the product being pumped by 6-in. Wilfley sand pumps to 15-ft. Dorr bowl classifiers, the oversize being ground in 7x10-ft. ball mills in closed circuit with 8x26 ft. 8 in. Dorr classifiers.

Mattless flotation cells have been installed. Three rougher cells are in series, the concentrate product of the first rougher being sent to the two cleaner cells of the mattless type, from which the tailing returns to the flotation distributor and the concentrate goes to thickeners and filters. Flotation concentrates from the second and third roughers are returned to the flotation distributor. The mill has eight units, each of 1,500 tons' capacity, or about 12,000 tons' total capacity. The standard fine grind is 15 per cent on 100 mesh. Flotation power has been reduced to 1.4 to 1.5 kw.-hr. per ton; total power for crushing and milling is about 12 kw.-hr. per ton, and in addition water supply requires 2.34 kw.-hr. per ton of ore. Heat-treated rods show a consumption of 0.34 to 0.42 lb. per ton and balls 1.465 lb. per ton.

At the Hurley power plant Heine boilers have been reconstructed and converted into five units, two boilers to a unit, and pulverized-coal firing equipment, Aero units, has been installed. A new 7,500-kw. Allis-Chalmers turbo-generator unit has been added to the 2,000- and 6,000-kw. turbo-generator units and three 1,250-hp. cross-compound Nordberg units. Chino has thus rehabilitated its mill and power plant and extended its ore reserves. It is in an excellent position.

Morenci presents a number of interesting developments, of which the proposed exploitation of the Clay orebody is the most important. Careful drilling has delineated the principal limits of this orebody and shows 245,000,000 tons or more with capping about 250 ft. thick. Present indications are that the ore can be mined by stripping and power-shovel mining, but no definite decision has been made as to the mining method. A millsite below Morenci has been tentatively selected and the preliminary work of determining all details of the project is now proceeding. A concentrator of 25,000 tons per day will be required. The first actual work will be the construction of a pilot mill and an experimental leaching plant. Four years will probably be required on preliminary testing and construction.

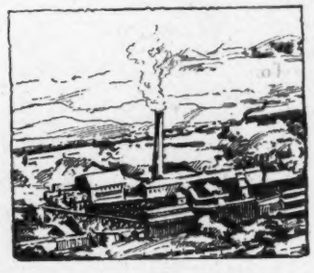
What it means to work out a horizon in a mine and to open out and begin work upon a lower one is exemplified by the Humboldt mine, at Morenci. No. 6 shaft has been sunk to the 1,800 level and the Joy shaft to the 1,400; and a new working level, the 1,400, has been developed with all of the necessary accessory workings and shaft pockets. New cables, hoist, and skips have been provided, and it was expected that production from this new lift would begin in July. The new hoist is a Nordberg double-drum, single-reduction gear hoist driven by a 750-hp. d.c. motor. A motor-generator flywheel set supplies current. Electrical equipment is Westinghouse. The new skips are constructed of manganese steel. Continued progress is being made in safety work in all departments and Morenci is establishing safety records both underground and on the surface that are serving to stimulate other organizations to better theirs.

Mill capacity has been increased from 4,300 to 5,000 tons per day (present operations are restricted to five days per week), and better grinding is now being accomplished as well as increased recoveries of sulphide mineral. From former grinding of 8 to 10 per cent on 65 mesh, the grind is now 1½ per cent on 65 mesh. Symons cone crushers and rolls in closed circuit with Hummer screens provide a fine feed for the primary ball mills after removing some concentrates by rougher tables. Secondary grinding in Marcy and Hardinge ball mills follows primary flotation and secondary flotation is followed by two scavenger cells in series. Thus, grinding is in two stages and flotation in two stages. MacIntosh and Forrester-type cells are in use. This last mill revamping has resulted in a splendid plant that compares favorably with other large mills.

Morenci receives its power from by-product heat boilers at its Clifton smelter and from a Diesel plant at Morenci. Recently a Nordberg Diesel-generator unit of 2,000-kva. size was installed, and it is in steady operation. At the Clifton smelter methods have been worked out for shutting down two days in each week, Saturday and Sunday. Roasters are shut down on the last shift on Friday and air is circulated through the rabble system and the rabbles are turned once an hour until the first shift on Monday. Three burners are kept going on the reverberatory furnace. An additional burner has been placed at the slag end of the furnace, and this serves to keep the slag fluid at the skimming end. When the furnace is brought to full operation on Monday morning, three or four ladles of matte are tapped at the start, and as soon as the furnace is up to normal heat, it is ready for its five-day run. On the converters the run is finished and the charge poured. A cover is then placed over the converter top and it is left until needed on Monday. It is of interest to note that Silocel insulation has been used upon the middle section of the converter between the shell and the magnesite lining. The blowing of a 50 per cent matte is facilitated by this heat insulation.

Most of the copper produced is refined, poled, and poured into P.D.M. ingots of exceptional purity. The next step in the production of refined copper at the Morenci branch will be casting of cakes. The casting equipment consists of an oxidizing vessel of 15 tons' capacity, which is oil-fired, and a reducing vessel of the same capacity mounted upon a carriage, so that after poling, copper is poured directly into stationery molds. This refining equipment has proved so successful that the same design has been adopted recently by the Copper Queen branch.

Bagdad is 40 miles west of Prescott and some 28 miles from Hillside on the Santa Fé railroad system. The Bagdad Corporation has been engaged for several years in the exploration and churn drilling of a porphyry copper deposit. It is now exploring by diamond drills from underground workings and is planning to begin work upon a test stope to be mined by the Miami system. In addition, systematic scout holes are being drilled and extensions from the main ore mass are being traced out. Superintendent G. G. Thomas estimates that the principal orebody, drilled upon 100- and 200-ft. squares, contains 46,000,000 tons of commercial ore. Topographical environment is difficult, but tentative plans for a main shaft and treatment plant have been made. Experiments upon a leaching process have been completed and the pilot flotation concentrator has been rebuilt by the Southwestern Engineering Corporation upon the basis of 200 tons per day and is now being operated upon development ore. Present development workings aggregate 10,000 ft. Power is generated by Fairbanks-Morse Diesels, of which two 360-hp. and one 180-hp. supply the present requirements. This is an enterprise in the making and is proceeding upon normal lines with an excellent plant and capable management.



Conversion Factors

Published by the courtesy of the engineering staff of E. I. du Pont de Nemours & Company

Volume and Weight

To Convert from	Multiply by														
	To Cu.In.	To Cu.Ft.	To Cu.Yd.	To Fl.Oz.	To Pint	To Quart	To Gallon	To Grain	To Oz. Troy	To Oz. Av.	To Lb. Troy	To Lb. Av.	To C.c. or G.	To Ltr. or Kg.	To Cu.M.
Cu.in.	1.00000	.$0_3$5787	.$0_4$2143	.554112	.034632	.017316	.004329	252.891	.526857	.578037	.043905	.036127	16.3871	.016387	.$0_4$1639
Cu.ft.	1728.00	1.00000	.037037	957.505	59.8442	29.9221	7.48052	436996	910.408	998.848	75.8674	62.4280	28316.9	28.3169	.028317
Cu.yd.	46656.0	27.0000	1.00000	25852.6	1615.79	807.896	201.974	11799$0_3$	24581.0	26968.9	2048.42	1685.56	764556	764.556	.764556
Fl. oz.	1.80469	.001044	.$0_4$3868	1.00000	.062500	.031250	.007813	456.390	.950813	1.04318	.079234	.065199	29.5736	.029573	.$0_4$2957
Pint	28.8750	.016710	.$0_3$6189	16.0000	1.00000	.500000	.125000	7302.23	15.2130	16.6908	1.26775	1.04318	473.177	.473177	.$0_4$4732
Quart	57.7500	.033420	.001238	32.0000	2.00000	1.00000	.250000	1460.45	30.4260	33.3816	2.53550	2.08635	946.354	.946354	.$0_3$9463
Gallon	231.000	.133681	.004951	128.000	8.00000	4.00000	1.00000	58417.9	121.704	133.527	10.1420	8.34541	3785.42	3.78542	.003785
Grain	.003954	.$0_5$2288	.$0_7$8475	.002191	.$0_3$1369	.$0_4$6850	.$0_4$1712	1.00000	.002083	.002286	.$0_3$1736	.$0_3$1428	.064799	.$0_4$6479	.$0_7$6479
Oz. troy	1.89805	.001098	.$0_4$4068	1.05173	.065733	.032867	.008217	480.000	1.00000	1.09714	.083333	.068571	31.1035	.031104	.$0_4$3110
Oz. av.	1.72999	.001001	.$0_4$3708	.958608	.059913	.029957	.007489	437.500	.911457	1.00000	.075955	.062500	28.3495	.028350	.$0_4$2835
Lb. troy	22.7766	.013181	.$0_3$4882	12.6208	.788800	.394400	.098600	5760.00	12.0000	13.1657	1.00000	.822857	373.242	.373242	.$0_3$3732
Lb. av.	27.6799	.016018	.$0_3$5933	15.3378	.958611	.479306	.119826	7000.00	14.5833	16.0000	1.21528	1.00000	453.593	.453593	.$0_3$4536
C.c. or gram.	.061024	.$0_4$3531	.$0_5$1308	.033814	.002113	.001057	.$0_3$2642	15.4323	.032151	.035274	.002679	.002205	1.00000	.001000	.000001
Liter or kg.	61.0237	.035315	.001308	33.8140	2.11337	1.05669	.264172	15432.3	32.1507	35.2739	2.67923	2.20462	1000.00	1.00000	.001000
Cu.m.	61023.7	35.3146	1.30795	33814.0	2113.37	1056.69	264.172	15432$0_3$	32150.7	35273.9	2679.23	2204.62	1000000	1000.00	1.00000

The small subnumeral following a zero indicates that the zero is to be taken that number of times; thus, .$0_3$1428 is equivalent to .0001428. Equivalents used in constructing table

1 inch = 2.540001 cm.

∴ 1 cu.in. = 16.387083 c.c. = 16.387083 grams H_2O at 4°C. = 39°F.

231 cu.in. = 1 gallon = 3,785.4162 grams.

1 lb. av. = 453.5926 grams

∴ 1 gal. = 8.34541 lb.

∴ 1 lb. av. = 27.679886 cu.in. H_2O at 4°C.

1 lb. av. = 7,000 grains.

∴ 1 gallon = 58,417.87 grains.

Temperature

$$F° = 9/5\ C° + 32 \qquad C° = 5/9\ (F° - 32)$$

Energy

To Convert from	Multiply by										
	B. T. U.	P. C. U.	Cal.	Ft. Lb.	Ft. Tons	Kg. M.	Hp. Hr.	Kw. Hr.	Joules	Lb. C	Lb. H_2O
B. T. U.	1.00000	.555556	.251996	778.000	.389001	107.563	.$0_3$3929	.$0_3$2931	1055.20	.$0_4$6876	.001031
P. C. U.	1.80000	1.00000	.453593	1400.40	.700202	193.613	.$0_3$7072	.$0_3$5276	1899.36	.$0_3$1238	.001855
Calories	3.96832	2.20462	1.00000	3091.36	1.54368	426.844	.001559	.001163	4187.37	.$0_3$2729	.004089
Ft. Lb.	.001285	.$0_3$7141	.$0_3$3239	1.00000	.000500	.138255	.$0_6$5050	.$0_6$3767	1.35625	.$0_7$8840	.$0_5$1325
Ft. Tons	2.57069	1.42816	.647804	2000.00	1.00000	276.511	.001010	.$0_3$7535	2712.59	.$0_3$1768	.002649
Kg. M.	.009297	.005165	.002343	7.23301	.003617	1.00000	.$0_5$3653	.$0_5$2725	9.81009	.$0_6$6394	.$0_5$9580
Hp. Hr.	2544.99	.141388	641.327	1980000	990.004	273747	1.00000	.746000	2685473	.175044	2.62261
Kw. Hr.	3411.57	1895.32	859.702	2654200	1327.10	366959	1.34041	1.00000	3599889	.234648	3.51562
Joules	.$0_3$9477	.$0_3$5265	.$0_3$2388	.737311	.$0_3$3687	.101937	.$0_6$3724	.$0_6$2778	1.00000	.$0_7$6518	.$0_6$9766
Lb. C	14544.0	8080.00	3665.03	113150$_3$	5657.63	1564396	5.71434	4.26285	153470$_3$	1.00000	14.9876
Lb. H_2O	970.400	539.111	244.537	754971	377.487	104379	.381270	.284424	1023966	.066744	1.00000

"P. C. U." refers to the "pound-centigrade unit." The ton used is 2,000 pounds. "Lb. C" refers to pounds of carbon oxidized 100% efficiency, equivalent to the corresponding number of heat units. "Lb. H_2O" refers to pounds of water evaporated at 100°C. = 212° F. at 100% efficiency.

Costs and Production of Michigan Mines

F. G. Pardee

Department of Conservation
Geological Survey Division, Lansing, Mich.

STATISTICS of 1929 production of copper and iron in Michigan have been compiled by official sources and are here presented, together with per-ton costs and complementary data. For iron ore, the five-year average costs are also made available.

Tons Mined and Shipped from Michigan Iron Mines in 1929

Shipment figures from statistics furnished by the Lake Superior Iron Ore Association

Dickinson County

	Shipped Tons	Mined Tons
Aragon	208,433	214,112
Chapin	432,275	438,873
Loretto	136,334	139,087
Penn Group	472,381	476,052
West Chapin	21,282	21,282
Total	1,270,705	1,289,406

Gogebic County

Anvil Group	480,244	410,747
Eureka-Asteroid	407,338	401,680
Ironton	587,646	608,800
Newport-Bonnie	652,012	636,138
Norrie Group	1,272,308	1,053,022
Plymouth	505,513	505,551
Puritan Group	560,680	498,701
Sunday Lake	589,826	620,161
Tilden	54,686	113,600
Townsite	171,862	84,202
Wakefield	631,316	620,636
Total	5,913,431	5,553,200

Iron County

Balkan-Judson	216,257	220,715
Baltic-Buck-Fogarty	153,675	161,312
Bates	125,843	159,565
Bengal	241,790	251,008
Berkshire	215,635	229,491
Bristol	562,836	501,115
Caspian	335,885	303,051
Davidson	311,631	289,645
Forbes	161,569	154,550
Hiawatha	208,960	201,400
Homer	176,749	166,253
James	302,301	263,020
Odgers	30,441	0
Riverton	240,375	233,558
Rogers	323,883	249,020
Tobin-Genesee	135,098	143,100
Virgil	175,078	165,163
Warner	177,429	182,422
Wauseca	50,305	68,366
Zimmerman	149,860	179,320
Total	4,295,600	4,124,074

Dickinson County

Average per-Ton Costs—Underground Iron Mines

Items	1928		1929		Five-Year Average	
Cost of Mining						
Labor	1.4836		1.3912		1.5447	
Supplies	0.4111		0.4198		0.4290	
Total	1.8947	1.8947	1.8110	1.8110	1.9737	1.9737
Deferred mining cost		0.0145		0.0289		0.0105
Taxes						
General property	0.2199		0.2088		0.2259	
State corporation	0.0025		0.0021		0.0035	
Federal corporation	0.0000		0.0000		0.0000	
Total	0.2224	0.2224	0.2109	0.2109	0.2294	0.2294
General overhead						
General office	0.0346		0.0268		0.0334	
General superintendence	0.0252		0.0235		0.0255	
Fire insurance	0.0032		0.0025		0.0024	
Contingent	0.0086		0.0077		0.0082	
Depreciation	0.0957		0.0839		0.0868	
Total	0.1673	0.1673	0.1444	0.1444	0.1553	0.1553
Transportation						
Rail freight	0.8217		0.8222		0.8217	
Boat freight	0.6320		0.6249		0.6181	
Cargo insurance	0.0016		0.0012		0.0011	
Total	1.4553	1.4553	1.4483	1.4485	1.4409	1.4409
Marketing						
Selling and operating commission	0.0411		0.0437		0.0376	
Analysis	0.0028		0.0032		0.0030	
Total	0.0439	0.0439	0.0469	0.0469	0.0406	0.0406
Total ore cost		3.7981		3.6904		3.8504
Lake Erie value per ton		4.3354		4.5613		4.2751
Gross ore profit (a)		0.5373		0.8709		0.4247
Other ore costs						
Royalty	0.3054		0.3038		0.2708	
Interest on borrowed money	0.0363		0.0313		0.0341	

(a) This figure does not represent true profit, as much ore is sold at a discount.

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Gogebic County

Average per-Ton Costs—Underground Iron Mines

Items	1928		1929		Five-Year Average	
Cost of mining						
Labor	1.0868		0.9687		1.1240	
Supplies	0.5251		0.5296		0.5166	
Total	1.6119	1.6119	1.4983	1.4983	1.6406	1.6406
Deferred mining cost		0.1274		0.1192		0.1153
Taxes						
General property	0.3264		0.2879		0.3005	
State corporation	0.0049		0.0036		0.0049	
Federal corporation	0.0000		0.0000		0.0002	
Total	0.3313	0.3313	0.2915	0.2915	0.3056	0.3056
General overhead						
General office	0.0255		0.0314		0.0317	
General superintendence	0.0223		0.0202		0.0221	
Fire insurance	0.0050		0.0038		0.0040	
Contingent	0.0100		0.0087		0.0094	
Depreciation	0.1808		0.1312		0.1538	
Total	0.2436	0.2436	0.1953	0.1953	0.2210	0.2210
Transportation						
Rail freight	0.8229		0.8204		0.8216	
Boat freight	0.8350		0.8356		0.8382	
Cargo insurance	0.0016		0.0017		0.0016	
Total	1.6595	1.6595	1.6577	1.6577	1.6614	1.6614
Marketing						
Selling and operating commission	0.0270		0.0238		0.0240	
Analysis	0.0032		0.0038		0.0039	
Total	0.0302	0.0302	0.0276	0.0276	0.0279	0.0279
Total ore cost		4.0039		3.7896		3.9718
Lake Erie value per ton		4.5872		4.6006		4.6149
Gross ore profit (a)		0.5833		0.8110		0.6431
Other ore costs						
Royalty	0.3606		0.3583		0.3592	
Interest on borrowed money	0.0827		0.0785		0.0713	

(a) This figure does not represent true profit, as much ore is sold at a discount.

Iron County

Average per-Ton Costs—Underground Iron Mines

Items	1928		1929		Five-Year Average	
Cost of mining						
Labor	0.7768		0.7784		0.8154	
Supplies	0.4683		0.4631		0.4850	
Total	1.2451	1.2451	1.2415	1.2415	1.3004	1.3004
Deferred mining cost		0.1169		0.0746		0.0962
Taxes						
General property	0.1854		0.1693		0.1732	
State corporation	0.0031		0.0058		0.0053	
Federal corporation	0.0000		0.0000		0.0007	
Total	0.1885	0.1885	0.1751	0.1751	0.1792	0.1792
General overhead						
General office	0.0602		0.0565		0.0540	
General superintendence	0.0366		0.0348		0.0336	
Fire insurance	0.0032		0.0030		0.0038	
Contingent	0.0088		0.0061		0.0056	
Depreciation	0.1216		0.1023		0.1067	
Total	0.2304	0.2304	0.2027	0.2027	0.2037	0.2307
Transportation						
Rail freight	0.8216		0.8214		0.8208	
Boat freight	0.6430		0.6344		0.6403	
Cargo insurance	0.0021		0.0017		0.0018	
Total	1.4667	1.4667	1.4575	1.4575	1.4629	1.4629
Marketing						
Selling and operating commission	0.0667		0.0688		0.0706	
Analysis	0.0049		0.0080		0.0060	
Total	0.0716	0.0716	0.0768	0.0768	0.0766	0.0766
Total ore cost		3.3192		3.2282		3.3290
Lake Erie value per ton		4.0336		4.3000		4.1097
Gross ore profit (a)		0.7144		1.0718		0.7907
Other ore costs						
Royalty	0.3049		0.3123		0.3083	
Interest on borrowed money	0.0210		0.0185		0.0285	

(a) This figure does not represent true profit, as musb ore is sold at a discount.

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Marquette Range

Average per-Ton Costs—Underground Iron Mines

Items	1928		1929		Five-Year Average	
Cost of Mining						
Labor	1.0728		0.9785		1.1284	
Supplies	0.6588		0.6339		0.6292	
Total	1.7316	1.7316	1.6124	1.6124	1.7576	1.7576
Deferred mining cost		0.0827		0.0927		0.0738
Taxes						
General property	0.2584		0.2313		0.2720	
State corporation	0.0223		0.0188		0.0213	
Federal corporation	0.0006		0.0000		0.0055	
Total	0.2813	0.2813	0.2501	0.2501	0.2988	0.2988
General overhead						
General office	0.0839		0.0964		0.0706	
General superintendence	0.0840		0.0721		0.0919	
Fire insurance	0.0020		0.0010		0.0022	
Contingent	0.0196		0.0035		0.0046	
Depreciation	0.0932		0.1006		0.0874	
Total	0.2827	0.2827	0.2736	0.2736	0.2468	0.2468
Transportation						
Rail freight	0.6798		0.6600		0.6704	
Boat freight	0.7188		0.7288		0.7229	
Cargo insurance	0.0028		0.0023		0.0026	
Total	1.4014	1.4014	1.3911	1.3911	1.3959	1.3959
Marketing						
Selling and operating commission	0.0846		0.0896		0.0840	
Analysis	0.0080		0.0056		0.0069	
Total	0.0926	0.0926	0.0952	0.0952	0.0909	0.0909
Total ore cost		3.8723		3.7151		3.8638
Lake Erie value per ton		4.5685		4.8394		4.6478
Gross ore profit (a)		0.6962		1.1243		0.7840
Other ore costs						
Royalty	0.1396		0.1537		0.1534	
Interest on borrowed money	0.0121		0.0132		0.0298	

(a) This figure does not represent true profit, as much ore is sold at a discount.

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Summary of Facts of Iron-Ore Production

Underground and Open-Pit Mines

	1925	1926	1927	1928	1929
Tons of ore mined	14,504,495	15,246,932	15,129,164	13,699,017	15,227,231
Tons of ore shipped	15,065,130	16,810,160	14,518,480	14,332,872	16,889,448
State and local taxes, paid by active mines	$3,601,962.47	$3,679,316.00	$3,882,061.58	$3,404,425.48	$3,436.058.17
State and local taxes, per ton mined	$0.2483	$0.2413	$0,2566	$0.2485	$0.2260
Average number of days worked	269	278	268	247	284
Average number of men employed	11,953	11,302	10,421	9,206	8,996
Average daily wage	$4.80	$4.856	$4.828	$4.704	$4.915
Average yearly earning	$1,291.20	$1,350.22	$1,293.95	$1,161.80	$1,395.77
Tons per man per day	.....	4.85	5.05	5.26	5.84

Marquette Range

	Shipped, Tons	Mined, Tons
Archibald	193,292	220,821
Athens	485,940	343,147
Austin	77,426	0
Blueberry	42,741	52,727
Cambria	246,747	161,844
Cliffs Shaft	510,930	421,314
Francis	58,009	0
Gardner-Mackinaw	95,397	117,224
Holmes	353,422	198,861
Imperial	102,850	91,374
Isabella	120,129	112,824
Lake Superior (Sec. 16)	298,240	278,411
Maas	479,812	331,922
Morris-Lloyd	638,234	435,430
Negaunee	637,960	552,417
Princeton	7,162	0
Republic	19,868	0
Richmond (New)	164,503	164,503
Stephenson	99,318	0
Tilden	441,769	441,769
Volunteer	335,963	335,963
Total	5,409,712	4,260,551

State Totals

Dickinson County	1,270,705	1,289,406
Gogebic County	5,913,431	5,553,200
Iron County	4,295,600	4,124,074
Marquette Range	5,409,712	4,260,551
Total	16,889,448	15,227,231

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Michigan Copper Production in 1929

	Pounds
Calumet & Hecla	
Conglomerate mine	35,377,000
Osceola Amygdaloid	18,237,000
Kearsarge Amygdaloid	36,705,000
Calumet Reclamation	25,991,000
Tamarack Reclamation	7,520,000
Copper Range	
Champion mine	20,660,701
Baltic mine	2,127,926
Trimountain mine	1,408,689
Isle Royale	10,864,085
Mohawk	20,043,265
Quincy	4,459,426
Seneca	2,999,882
Total	186,393,974

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General Facts Pertaining to Michigan Copper Mining Industry for 1929

Tons of copper rock treated	
Mines only, tons	5,151,553
Mines and reclamations, tons	7,595,553
Pounds of copper produced, pounds	186,393,974
Pounds of copper produced per ton of rock treated	
Mines only, pounds	29.677
Mines and reclamations, pounds	24.539
Average price received for sale of copper cents	17.8511
Gross value of copper produced	$30,222,947.27
Number of days worked	310
Tons per man underground per day	3.89
Tons per man per day surface and underground (includes reclamations)	3.07
Average number of men employed	9,117

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Average Cost Per Pound Michigan Copper Production for 1929

	Cost in Cents per Pound Mines Only	
General expense		
General property tax	0.4430	
State corporation tax	0.0534	
Depreciation	1.4167	
General office	0.1287	
Other general expenses	0.5328	
Total	2.5746	2.5746
Mining cost		
Labor	5.3984	
Supplies	2.8191	
Total	8.2175	8.2175
Treatment cost		
Transportation (rock to mill)	0.4194	
Concentrating	1.2778	
Transportation to smelter	0.0427	
Smelting and refining	0.7376	
Total	2.4775	2.4775
Selling and delivery expense		0.4240
Total gross cost		13.6936
Average price of copper		17.8511
Average profit		4.1575
Other costs		
Construction and installation of equipment	0.5795	
Income tax	0.3705	

Siliceous Iron-Ore Open Pits

Average per-Ton Costs

Items	1928		1929		Five Year Average	
Cost of mining						
Labor	0.1659		0.1682		0.1896	
Supplies	0.2664		0.2321		0.2688	
Total	0.4323	0.4323	0.4003	0.4003	0.4584	0.4584
Deferred mining cost		0.0629		0.0334		0.0443
Taxes						
General property	0.0525		0.0377		0.0365	
State corporation	0.0078		0.0041		0.0101	
Federal corporation	0.0000		0.0000		0.0021	
Total	0.0603	0.0603	0.0418	0.0418	0.0487	0.0487
General overhead						
General office	0.0339		0.0226		0.0316	
General superintendence	0.0321		0.0179		0.0262	
Fire insurance	0.0037		0.0008		0.0015	
Contingent	0.0021		0.0002		0.0001	
Depreciation	0.0981		0.1130		0.0978	
Total	0.1699	0.1699	0.1545	0.1545	0.1572	0.1572
Transportation						
Rail freight	0.6694		0.6518		0.6971	
Boat freight	0.7364		0.7413		0.7475	
Cargo insurance	0.0026		0.0009		0.0019	
Total	1.4084	1.4084	1.3940	1.3940	1.4465	1.4465
Marketing						
Selling and operating commission	0.8019		0.0890		0.0855	
Analysis	0.0061		0.0094		0.0133	
Total	0.0880	0.0880	0.0984	0.0984	0.0988	0.0988
Total ore cost		2.2218		2.1224		2.2536
Lake Erie value per ton		2.2094		2.2849		2.3076
Gross ore profit (a)		0.0124		0.1625		0.0537
Other ore costs						
Royalty	0.1234		0.0834		0.1003	
Interest on borrowed money	0.0031		0.0017		0.0121	

(a) This figure does not represent true profit, as much ore is sold at a discount.

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State Summary

Average per-Ton Costs—Underground Iron Mines

Items	1928		1929		Five Year Average	
Cost of mining						
Labor	1.0237		0.9521		1.0662	
Supplies	0.5291		0.5240		0.5237	
Total	1.5528	1.5528	1.4761	1.4761	1.5899	1.5899
Deferred mining cost		0.1014		0.0898		0.0898
Taxes						
General property	0.2533		0.2287		0.2462	
State corporation	0.0085		0.0079		0.0086	
Federal corporation	0.0000		0.0000		0.0015	
Total	0.2618	0.2618	0.2366	0.2366	0.2563	0.2563
General overhead						
General office	0.0522		0.0551		0.0478	
General superintendence	0.0427		0.0381		0.0397	
Fire insurance	0.0034		0.0027		0.0034	
Contingent	0.0119		0.0065		0.0070	
Depreciation	0.1312		0.1099		0.1173	
Total	0.2414	0.2414	0.2123	0.2123	0.2152	0.2152
Transportation						
Rail freight	0.7871		0.7687		0.7842	
Boat freight	0.7320		0.7440		0.7448	
Cargo insurance	0.0020		0.0019		0.0018	
Total	1.5211	1.5211	1.5146	1.5146	1.5308	1.5308
Marketing						
Selling and operating commission	0.0559		0.0585		0.0544	
Analysis	0.0048		0.0055		0.0051	
Total	0.0607	0.0607	0.0640	0.0640	0.0595	0.0595
Total ore cost		3.7392		3.5934		3.7415
Lake Erie value per ton		4.3959		4.5838		4.4386
Gross ore profit (a)		0.6567		0.9904		0.6961
Other ore costs						
Royalty	0.2779		0.2778		0.2838	
Interest on borrowed money	0.0405		0.0387		0.0446	

(a) This figure does not represent true profit as much ore is sold at a discount.

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Total Iron Ore Production and Value

	1928		1929	
	Tonnage	Total Value	Tonnage	Total Value
Dickinson County	4,886,465	$3,520,000	4,087,207	$3,330,000
Gogebic County	48,587,126	37,171,000	51,347,176	36,893,000
Iron County	58,035,954	20,835,000	57,260,057	21,162,000
Marquette Range	57,920,862	28,232,000	55,655,383	28,523,000
Total	169,430,407	$89,758,000	168,349,823	$89,908,000

Average Cost Per Pound Michigan Copper Production for 1925-1929 Inclusive

	Cost in Cents per Pound Mines Only	
General expense		
General property tax	0.4838	
State corporation tax	0.0531	
Depreciation	1.3479	
General office	0.1250	
Other general expense	0.4984	
Total	2.5082	2.5082
Mining cost		
Labor	4.0835	
Supplies	2.5514	
Total	7.3549	7.3549
Treatment cost		
Transportation (rock to mill)	0.4290	
Concentration	1.1905	
Transportation to smelter	0.0459	
Smelting and refining	0.7571	
Total	2.4225	2.4225
Selling and delivering expense	.....	0.4285
Total gross cost	.....	12.7141
Average price of copper	.....	14.8655
Average profit	.....	2.1514
Other costs		
Construction and installation of Equipment	0.5392	
Income tax	0.2017	

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Valuations of Copper Mines

Mine	1930
Keweenaw County	
Calumet & Hecla	
Cliff & Phoenix	$100,000
Ahmeek & Allouez	6,450,000
Mohawk	2,200,000
Seneca	850,000
Douglass Copper Company	40,000
Total Keweenaw County	$9,640,000
Houghton County	
Calumet & Hecla	
Ahmeek Mill & Railroad	$800,000
Centennial	200,000
Calumet & Hecla Conglomerate	3,045,000
Osceola	1,750,000
North Kearsarge	300,000
Reclamation	10,000,000
Total	$16,095,000
Copper Range	
Champion mine	$43,215,000
Baltic mine	150,000
Trimountain	100,000
Total	$3,465,000
Isle Royale	$1,250,000
Quincy (this includes railroad)	1,250,000
Arcadian Consolidated Copper	90,000
Franklin Mining Company	100,000
Mayflower-Old Colony	40,000
Hancock Consolidated Copper	49,000
LaSalle Copper	80,000
Superior Copper	20,000
Winona Copper	65,000
Total Houghton County	$22,504,000
Grand total—Houghton & Keweenaw counties	$32,144,000
Refined copper—Houghton County	$1,224,610

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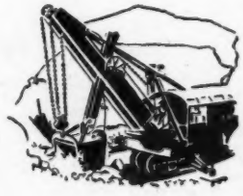

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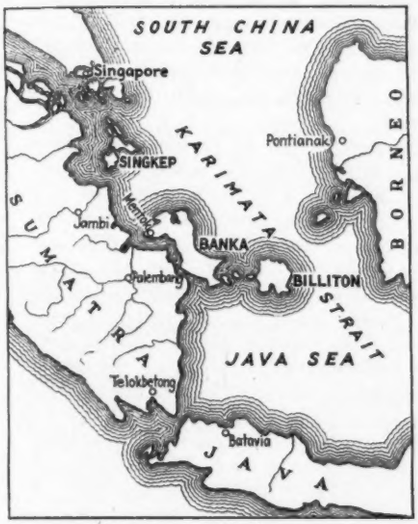
TIN MINING and SMELTING IN THE NETHERLANDS EAST INDIES

Hendrik de Leeuw



Map of tin-producing islands in Dutch East Indies

THE most important minerals mined in the Netherlands East Indies are tin, coal, and petroleum. Banka, Billiton, and Singkep—on the southeasterly extension of the axis of the Malay Peninsula—are the great tin-producing islands, on the first of which tin mining is a government enterprise.

The Malay States, including the aforenamed islands, rank first in the world's tin supply. Bolivia ranks second, and the remainder is supplied by Cornwall, Australia, China, Nigeria, South Africa, and Alaska. Tin was discovered in Banka in 1710. The original enterprises were under domestic control. The Chinese reorganized the industry, and, by introducing several important improvements, they put tin mining on a systematic basis. Billiton's tin-mining industry dates from 1851, when its first mine was put in operation A few years later the Singkep company was organized.

On the island of Banka, the tin ores are found in alluvial deposits along the eastern and northern coasts. The exposed formations are granites and sedimentaries—of quartzites, sandstone, and Paleozoic shales. Strata are compressed into steep folds. Small veins of ore also occur in the granite. The overburden is sand, clay, and gravel. Banka's primary tin deposits are in ancient sediments, more as impregnations than as veins. The granites contain cassiterite and topaz. Vein material includes cassiterite, magnetite, siderite, wolframite, pyrite, and tourmaline. The alluvial strata in Billiton are grouped and named after the manner in which they are worked, as the "kollongs" and "koelits." The first are of comparatively recent origin, the tin occurring scattered through the alluvium in uniform quantities or in tin-bearing strata, separated by lean or barren ground. Usually they are covered by a barren overburden of clay and sand, from 10 to 20 ft. thick. The "koelits," worked by direct washing or panning, lie above sea level. The "kollongs" are far below sea level.

On the island of Billiton the occurrence of tin and the geological conditions are in the main similar to those on Banka. Here are also some large and rich veins, of great promise. Mining conditions at Singkep are similar to those at Billiton and Banka, except that ore is also found at the sea bottom and is worked by dredges. The methods used are similar throughout the Netherlands East Indies. As my visits covered only the Billiton tin mines, I will confine myself to surveying that island's industry.

Originally, all tin mining was by hand; a few properties still follow primitive methods. The ground is mined as a gravel pit would be opened. A rivulet supplies the necessary water, and those deposits are worked where sufficient flooding follows. Coolies loosen the wash dirt with the "patjol" or hoe, fill their baskets, and carry the dirt to the washing sluices. At first the coolies used the Chinese chain pump,

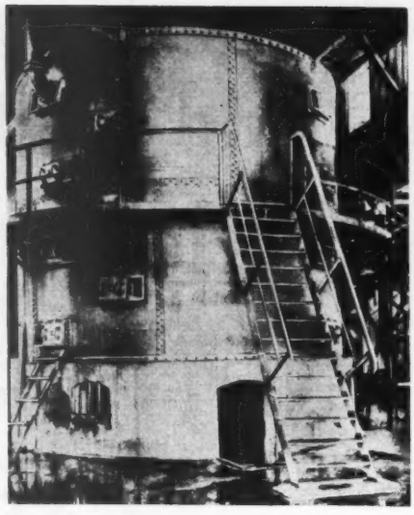
Building a dam with tailing

driven by a water wheel. Mechanical power later displaced these appliances. Small steam engines, burning wood fuel, were used for raising the water, for pumping water for washing purposes, or for elevating the dirt. Still later, all these gave way to the more modern system of transport—a car running on a cable. In this manner, deeper terrains could be worked.

The hydraulic method is also used in Banka and Billiton. Ground is broken by jets played from a monitor against the deposit, the water also washing the material to the sluices. The hydraulic pumps work under various pressures from heights of 50 to 500 ft. The cost of pumping is about 20c. per cubic meter, under less favorable conditions running as high as 40 to 50c. Ground displacement per coolie is high. As an important consideration is to remove as much dirt with as little water as possible, the favorable mixture percentage, running from 4 to 12 per cent dirt, has proved this type of tin mining to be satisfactory.

Hydro-electric mining is usually resorted to where water under sufficient head is not available. Gravel pumps elevate the tin-bearing ground or tailing. The gravel pump is usually a centrifugal pump, capable of raising any stone entering its suction.

Bucket dredging, originally confined to the island of Singkep, is now extensively practiced elsewhere with great success. The dredge is placed on a pontoon. The dirt is raised by buckets on an endless chain of the closed or the open type. In the closed type the buckets are connected; the open type has a link between each pair. The material scooped up by the buckets, which varies in amount from 7 to 12 cu.ft., is transported to a revolving sieve drum, called a cribler, where the stones are separated and the earth is disintegrated. A pipe runs through the cribler, playing jets of water. At the end of the drum a monitor plays powerful jets to the inside. Baffles are placed on the inside of the drum to break up the stones.



Roasting furnace used in Dutch East Indies

Maneuvering these huge dredges requires skill. A winch system on the deck of the float moves the dredge forward or backward. Dredging is continued until the bucket strikes lean and unprofitable strata, and then the dredge is moved to another location.

The bucket dredges in operation at Billiton excavate from 500,000 cu.m. to 1,000,000 cu.m. per year—as much as could be done by 1,000 to 2,000 men. A bucket dredge, displacing 1,000,000 cu.m. per year, requires 200 hp. A suction or pump dredge that would work the same ground would require at least 1,000 hp. and many coolies. Little water is brought up with the earth. Motors and centrifugal pumps are operated on the pontoons. A modern dredge has six pumps, each using 90 hp. and pumping 4 to 6 cu.m. per minute.

The first tin-washing mill was installed a few years ago on a pontoon and is still in use at Ajer Sidjoek, in the district of Tandjong Pandan. The material flows to the rear of the dredge, where the mixture is washed on tables—tail races in series of eight, placed in two tiers.

The newest dredge in use at Billiton is of American manufacture—a Bucyrus, of strong construction, able to dredge to 16.75 and 18 m. in depth, bringing up 20 buckets per minute, each holding 7 cu.ft. Dredge and cribler, each taking about 150 hp., are furnished with central pumps for wash water, ballasts and motors for revolving the cribler, and winches. On three of these machines, the tables have been replaced by jigs and classifiers, to work the primary ores.

Gravel pumps of various types have been tried. The first installed was also the largest. The fan was incased in a two-sided pump box with hard-iron lining and covers. The suction pipe was connected on one side and the water box and packing on the other. Against the lining cover was a membrane, supplied with a rubber washer, which prevented sand from entering the box. This pump, mounted on the big dredge, proved satisfactory. Eight-inch pumps are used for smaller developments, with renewable liner and wearing plates. The pumped material carries about 5 per cent solids by bulk.

The suction dredges, known in Billiton as the "spuitbaggers," are also in extensive use in Australia and the Straits Settlements. Two suction dredges operating in Billiton are driven by steam and one dredge is driven electrically. The jets of the dredge require from 50 to 125 hp., the suction pumps 165 to 500 hp. The dredges displace 1,245,396 cu.m. of ground per year. In an hour 50 cu.m. can be broken down with a suction pump, whereas a dredge can move 100 cu.m. The expense of displacement is about 30c. per cubic meter.

For profitable bucket dredging the recovery should be over 0.5 lb. concentrate containing between 60 to 70 per cent tin per cubic yard. The average in the Malay states is well over 0.75 lb. per cubic yard. The bucket dredges have taken Billiton by storm, repeating their great success at Singkep, New Zealand, and California.

Lode mining, compared to dredging, is as yet of small importance in the Malay States. The technical difficulties in connection with it are many. The future of mining primary ore is difficult to forecast. Great depths have not been worked, the ore to date having been taken mostly from open pits. Tunnel methods are used if the tin-bearing deposits occur deeper. Great use is being made of the diamond drill.

Like the alluvial ore, reduced before smelting to a concentrate exclusively SnO_2, the primary ore must be freed

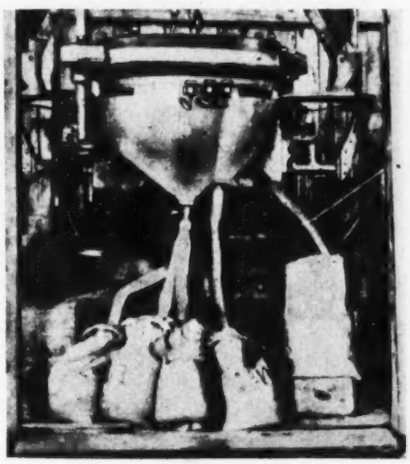
Tail race for alluvial tin ore

from many impurities, by gravity. Those impurities of a specific gravity approaching that of tin ore are wolframite, tourmaline, and pyrites. The closer the specific gravity of the impurity approaches that of the ore, the more difficult, complicated, and costly becomes its separation.

The ore is first treated in a Blake crusher, further reduction taking place again in crushers and stamp batteries, or Hardinge ball mills, according to the character of the ore. For grinding in the Hardinge mills, steel balls or 5-in. pebbles are used.

Mill pulp is first classified to size, by treating it in a Sturtevant rotary sieve or in settling classifiers. The coarse product is handled in Krupp jigs or by Setz machines. Smaller particles are washed on James concentrating tables. The middlings are washed again separately on James slime tables or buddles.

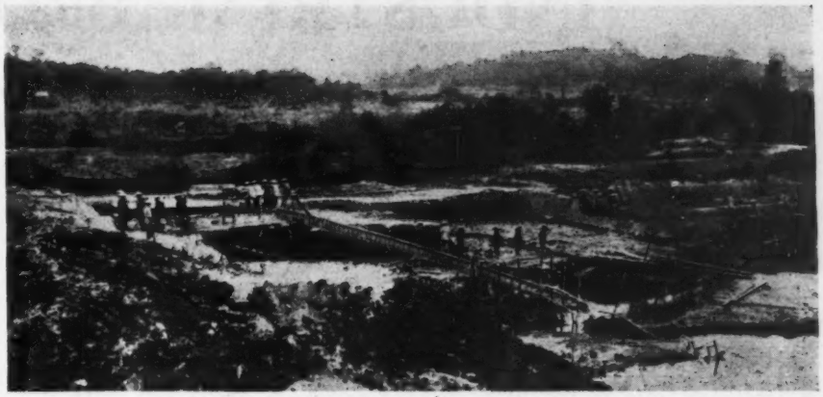
Pyrites and mispickel concentrates are treated by working the ore to



Magnetic separator at Billiton

a concentrate containing 20 to 30 per cent tin, followed by roasting at 550 deg. C. with access to the air. The pyrites are burnt, and a porous iron oxide forms, easily washed away. If the ore contains wolframite, magnetic separators are used. The Billiton company operates seven such separators, of which one is for wet separation.

Methods employed in smelting tin at the central smelter at Billiton are as follows: Besides three Vlaanderen roasters, there are at Billiton three flame or blast roasters, of which two have a capacity of 50 tons (80 piculs) of ore, and one has a capacity of ten tons, with roasting oven and refinery. In the flame oven the furnace is fed by gas generated from coal in a separate generator. Into the oven is brought a charge composed of ore, coke or coal, lime or iron ore. The flame roaster does not produce a fine tin in the initial process, so a second refining is necessary, but the final product is much better than that obtained from the open Vlaanderen ovens.



Banka tin mine under government control

Roasting removes the sulphur and other impurities. The arsenic compounds are rapidly oxidized, but sulphur remains one of the most annoying constituents. In this oven, the sulphur-bearing ore gradually moves from the least-heated to the strongest-heated point of the oven, as the sulphur is oxidized and escapes as sulphur dioxide.

The power required for most of the installation at Billiton is furnished by the Electric Central plant, constructed in 1914 at Semak. It is composed of three Diesel engines each of 1,200 hp., giving 2,400 kw. at a voltage of 3,000. This is transformed to 30,000 volts, carried along a high-tension conduit for 30 km., and transformed at destination again to 3,000 and 500 volts.

The Electric Central supplies the whole island of Billiton with power. Tandjong Pandan has two smaller Centrals, and Assam Belobang supplies a large development in North Rajah.

Labor for the mines, either at Billiton, Banka, or Singkep, mostly Chinese, is recruited through a central recruiting station from densely populated provinces of China, such as Koon Sie Sen, Fo Nam Sen, Ljian Toe Souw, Foek Kian, and Sen. Miners at work in Billiton number 20,000. They make excellent laborers, having a keen mechanical mind, good judgment, and initiative.

All workers have a contract with the company, even unskilled labor. The recruiting cost per laborer is about $32. His wage for the first year is about $6 per month, and food. When his debt to the company is discharged he can seek work wherever he likes. The third year, the Lobraks, or old laborers, usually take a trip back to China, and sometimes undertake to recruit, earning in this way a premium. The coolies are shipped and inspected at Swatow or Hongkong. On arrival at Billiton, they are examined. They receive a typhoid-cholera injection, undergo a hookworm cure, are indexed, and receive a card, after having signed the coolie contract. The wage at Singkep is usually 10c. per day; and the coolie also receives rice free. Later on, the company furnishes rice at cost price. The employment of labor is often based on the wage system of piece work. Mines are also leased to the laborers for a fixed percentage of the output.

■

Gravity Concentration of Phosphate Rejects

FLORIDA, which produced in 1928 about 82 per cent of the phosphate rock sold in the United States, has two producing areas, the hard-rock and the land-pebble district. In the land-pebble area, supplying about 80 per cent of the nation's requirement, the deposits consist of beds of phosphate matrix, covered with barren sands and clays. The overburden, up to 45 ft. thick, is removed by hydraulic methods or by dragline excavation, and the matrix, ordinarily less than 25 ft. thick, is mined by hydraulicking and pumped to the treatment plant, where the coarser pebbles are recovered and the low-grade phosphatic sand is rejected.

Report of Investigations No. 3018 of the U. S. Bureau of Mines contains a description of laboratory tests conducted by H. M. Lawrence and R. G. O'Meara to determine the possibility of treating the phosphate reject by hydraulic classification, either alone or followed by table concentration. Concentrates with an analysis above the minimum grade of commercial phosphate rock (66 per cent bone phosphate of lime) were obtained. Recovery of phosphate varied, but was promising enough to warrant further study. A summary of results follows:

1. Gravity concentration — hydraulic classification, either alone or followed by table concentration—has been applied in the laboratory to the treatment of certain types of low-grade phosphatic sands now rejected as waste by washing plants in the Florida land-pebble district.

2. Concentrates were produced with a higher phosphate content than the minimum commercial grade now regularly marketed in the district. The recoveries ranged from 35 to 45 per cent of the phosphate content of the sands treated.

3. If products containing 60 per cent bone phosphate of lime can be utilized by the industry, the indicated recoveries range from 43 to 83 per cent of the phosphate content of the sands that were studied in this investigation.

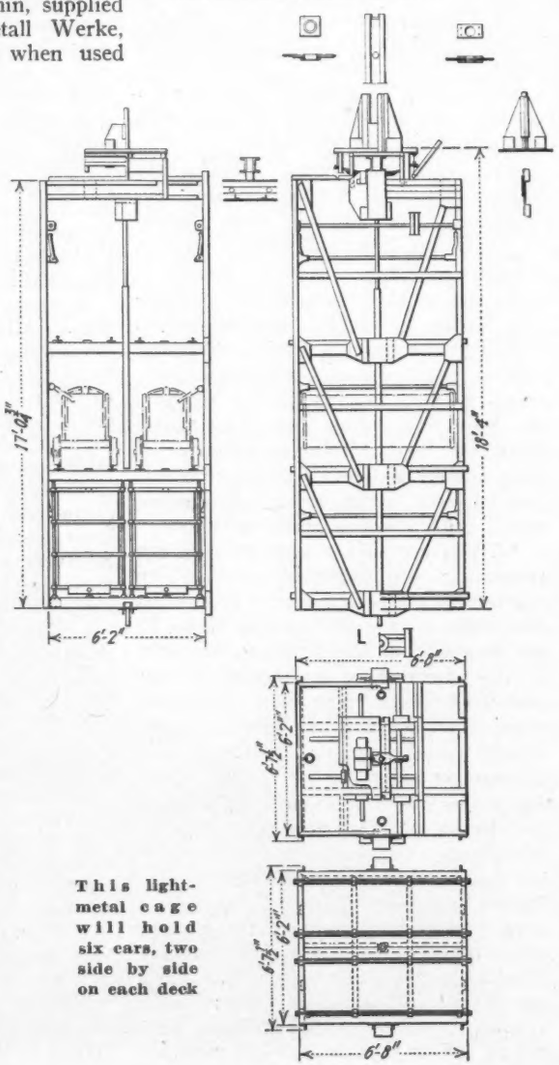
INDUSTRIAL PROGRESS

Cages of Aluminum Alloy Have Advantages of Lighter Weight

UNDER certain conditions, mine cages made of metal lighter than ingot steel may offer advantages that more than make up for their increased cost. Where the hoisting engine is already being strained to the limit of capacity, and the operator wishes to sink the shaft to greater depth or to increase the useful load carried by the cage, the solution to the problem may be found in substitution of the lighter cage. The accompanying outline sketches, showing multiple-deck cages made of light metal, have been prepared from working drawings furnished by Demag, Duisburg, Germany. The metal used, according to the company, is duralumin, supplied by the Dürener Leichtmetall Werke, Düren, Rheinland. Even when used in wet shafts, this material will not corrode when connected with iron. The company states that it tested it for months before deciding on the manufacture of the first light metal cage.

Substitution of a light metal cage for the one of heavier construction is the only solution to the problem mentioned above other than that of replacing the hoist with one of larger capacity. Such substitution may be a means of saving a mining company considerable expense. The lighter cage gives a further advantage in that it favorably affects the diameter and weight of rope, as will readily be seen. Still another advantage is that by solving the problem thus, no time is lost and the mine plant is not tied up, as it might be were it necessary to tear out a hoist and substitute a new one.

Under conditions where the problem mentioned does not arise, it may nevertheless be possible to gain some advantage by substituting a light-metal cage for a heavier one, in that the load of ore hoisted each trip may thereby be increased without increasing the total load on the hoist; or, if the weight of ore hoisted be unchanged, the power consumption may be decreased by using the lighter cage. Likewise, it will be possible to employ higher rates of acceleration in starting the hoist, as well as correspondingly higher rates of retardation when stopping. This means that the time required for a round trip is shortened and the number of round trips per hour and the mine output are correspondingly increased.



This light-metal cage will hold six cars, two side by side on each deck

When designing new plants, the adoption of light metal cages from the outset may also be found advantageous, inasmuch as their effect upon the dimensions of all other parts of the plant will be beneficial. The ropes may be made thinner, with a corresponding decrease in the diameter of the sheaves, as well as that of the rope drum or other hoisting gear.

■

Lubrication Lessons Still To Be Learned

An engineer who has recently studied the lubrication practice of fifteen mining companies says that his investigation has given him a good idea as to how much obsolete, old, oil- and grease-eating machinery is still in use at various properties. There is still great opportunity for making improvements in this respect. As an example, he cites one company employing about 1,500 men and with an annual smelting capacity of 1,200,000 tons, which purchased in 1929 about $8,400 worth of oils and greases. In contrast, another company with exactly one-third the capacity, purchased more than $11,000 worth. This latter company, he says, was still using the old-fashioned car trucks without roller bearings, the grease and oil being introduced without any lubricating device whatsoever.

■

For Fighting Mine Fires

An adustable pneumatic brattice for use in combating mint fires has been added to the line of the E. D. Bullard Company. It was developed by V. T. Burner, of the Nevada Consolidated Copper Company, after years of mine rescue experience. It is light, easily handled and erected, and efficient in preventing passage of air.

Individually constructed brattices like this one have been used successfully for years, but in each case they have cost more than the new device which is made in quantity.

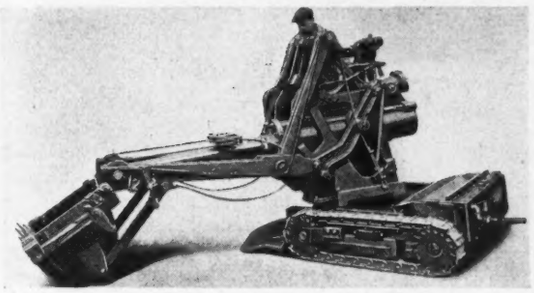
■

For Wrapping Pipe Lines

For wrapping pipe lines a machine has been developed which wraps all sizes of pipe from 4 to 24 in. at a uniform speed of 15 linear feet per minute. This is a joint product of the Johns-Manville Corporation and W. K. M. Company. Asbestos felt wrapping used to prevent corrosion is applied so as to give a 1-in. lap.

Crawler Mounting Applied to Underground Shovel

Vibrating Pan Feeder for Heavy Duty —New Stoper Rapid and Light

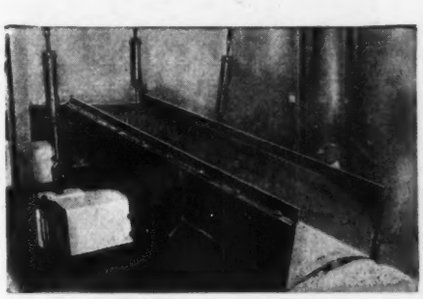


Mobility of this shovel has been increased by providing a crawler mounting

JUST as manufacturers of large shovels have widely adopted the caterpillar mounting for their excavators, the Nordberg Manufacturing Company has developed a crawler type of the Nordberg-Butler shovel. The new model by reason of its increased mobility is expected to meet with wider favor among operators. It will do whatever the rail-mounted machine was able to do and in addition can be handled with greater convenience. It does away with the necessity of track preparation. For handling loaded cars, it is necessary only to lay down short, temporary track sections until sufficient advance has been made to lay rails of full length. In a comparative test on the same job with the two types of shovels, the crawler model is reported to have cut the over-all loading time in half. Being full-revolving, it will load into cars from either side or directly back of the shovel.

The crawler is of all-steel construction, the treads being made of special alloy steel. Each tread is driven by a separate four-cylinder air motor, so arranged that both treads can be run in either direction or in opposite directions. The treads are short and the shovel may be turned in an 8-ft. circle. The crawlers are controlled by two levers shown in the cut on the rear of the mounting. In front of the shovel is a wide shoe which takes the downward strain exerted by the dipper in digging and which can be raised when the shovel is to be moved, although ordinarily it is not necessary to raise it.

In common with the rail-mounted model, this shovel runs on compressed air from the regular mine air system. All movements of the dipper from the crowd to dumping are secured from a direct-acting thrust cylinder. The shovel will operate in a drift 6 ft. wide at the dipper height. With crawler, it weighs 7,500 lb.



Capacity of this pan feeder is 200 tons per hour

A Vibrating Pan Feeder

For accurately controlling the tonnage fed to rolls, the Traylor Vibrator Company, Denver, Colo., has devised a heavy-duty vibrating pan feeder. This is shown in a cut. The vibrating deck is 10 ft. long, 2 ft. wide, and 1 ft. deep. Although the unit is hung from vibration absorbers, it may be mounted on the floor, because all vibration is confined to the feeder. The bottom of the feeder is convex and discharges evenly over the face of the rolls, thereby lessening corrugation.

The feeder may be operated on any of the usual a.c. circuits. Positive control of vibration is effected by means of a small motor-generator set. With the rheostat open, the maximum speed of travel with the pan loaded is 30 to 40 ft. a minute. This may be decreased almost to zero by closing the rheostat. The feeder (Type VCS6) has a capacity of 200 tons per hour. It can be operated at angles as steep as 18 deg. up hill without excessive loss of capacity, as well as on the level or down hill.

Leather-Belt Making Improved

A new so-called "tension cementing" process of making flat leather belt has been developed by Graton & Knight Company, Worcester, Mass. To this end the company has developed a unique type of belt-making machinery, for which it will apply for patent. The new machinery, it is said, practically eliminates the possibility of error due to the human equation. The cement used is waterproof, extremely flexible, has a very high heat crystallization point, and its entirely mechanical application is said to insure more uniform and much longer adhesion than has ever before been possible in cementing laps and plies of leather belting. Savings in maintenance and in operation and production costs are said to be possible because belting thus made has a greater, more uniform adhesion in laps and plies, insuring more continuous trouble-free operation; because its added flexibility makes it a better power transmitter and gives it longer life; because the high heat crystallization point of the cement enables it to withstand frictional heat better; and for the reason that it is waterproof, and thus permits use in any part of the plant.

A New Self-Rotating Stoper

Experimental work on a new self-rotating stoper (S-17) has been completed by the Cleveland Rock Drill Company, Cleveland, Ohio. The tests are reported to have shown that besides having lightness and speed, the new drill is economical in air consumption. An outstanding feature is its "trip rotation." This facilitates collaring the hole in contrast to the ordinary self-rotating stoper. By twisting the hand grip on the rotating handle, the machine man can stop the rotation at will. Thus when he is collaring the hole, he can let the hammer run on light air with the automatic rotation cut out, simply rocking the machine slightly by hand. Or, if he prefers, he can start and

Lightness, speed and low consumption of air are claimed for this new stoper

stop the rotation whenever he likes while starting the hole, an advantage where the rock face is irregular. With the trip rotation, moreover, holes may be kept from rifling.

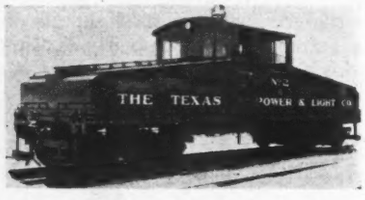
Another control that in this drill is said to be very effective is the air-feed button, located slightly above and right of the throttle handle. By pressing this with the left thumb, the operator can weaken the air feed whenever he encounter fitchery ground or a soft spot.

A feature claimed for the rotating handle is that if the machine were subjected to a bad fall, so that the whole weight comes upon the handle and bends it, the mechanism will not be put out of commission.

The Cleveland company has also begun to sell its Model H-6 light sinker. Two of these sinkers can be run on an ordinary 100 to 200 cu.ft. portable compressor.

Other New Locomotives

A new storage-battery locomotive weighing 100,000 lb., and having a rated drawbar pull of 18,000 lb. at 5 miles per hour, has been introduced by the Atlas Car & Manufacturing Company, Cleveland, Ohio. Motor and battery equipment used are duplicates of the equipment for a 25-ton locomotive which the same company had in service for several years. The locomotive has four 75-hp. motors, the contactor type of control, and a battery consisting of 200 cells MVA-41 Exide-Ironclad. It is fitted with the usual accessory equipment.



A new 50-ton storage battery locomotive

Two large oil-electric locomotives, 80 to 90 tons in weight, have recently been completed by George D. Whitcomb Company, Rochelle, Ill., for the Milwaukee Railroad. These are made in a 0-8-0 rigid wheelbase. The company is also building other oil-electric locomotives in a four-wheel type, as well as a 0-4-4-0, which is a double-truck type.

The new Ford "AA" truck power plant has been used to power two new series of light locomotives by the Brookville Locomotive Company, Brookville, Pa. These are being produced in 2-, 2½-, 3-, 3½-, and 4-ton sizes. A 4-speed heavy-duty Ford transmission and a Brookville reverse drive is used, making all four forward speeds available in either direction. The 4-ton locomotive can negotiate light trackage without derailment at a speed of 15 miles per hour, owing to the use of spring journals, wide wheels, and deep flanges. The entire power plant being used without alteration, service is always available from Ford dealers.

This plant locomotive is Ford-powered

In this 1¼-in. acid-proof pump the motor is mounted directly on pump structure

For Pumping Acid Solutions

A 1¼-in. centrifugal pump having casing and impeller acid-proofed with Olivite has been introduced by Oliver United Filters, Inc., San Francisco. Olivite combines the chemical-resistant qualities of hard rubber with a relatively high tensile strength, withstands comparatively high temperatures, and does not crack. It is vulcanized directly to the iron casing and impeller by a process which insures an absolute bond at all temperatures and speeds. This type of pump has been on the market for several years. Besides adding the 1¼-in. size, the company has improved the 2-in. size. Maximum head of the 1¼-in. pump is 60 ft. and of the 2-in. model 100 ft. at 1,750 r.p.m. The 1¼-in. size is unique in design. Its low power consumption permits the use of one size of motor, so that the latter may be mounted directly on the pump structure instead of on a sub-base, this insuring rigidity, eliminating the need for bearings in the pump, and making the unit self-contained and compact.

New Six Wheelers

Mining companies using motor trucks will be interested in two new six-wheel models of the two-wheel-drive type which have been recently introduced by Relay Motors Corporation, Lima, Ohio. In these models the company's system of pendulum suspension has been incorporated on all four rear wheels. A basic feature of this type of suspension is the fact that the upward swing of the load automatically increases the downward pressure on the wheels, greatly adding to the tractive force.

Self-contained Wilfley table of laboratory size

A Laboratory Wilfley

A laboratory model of the Wilfley table may now be had in a self-contained unit, with a ¼-hp. motor and a V-belt drive, according to the Mine & Smelter Supply Company, Denver. It is intended for use in laboratories and in commercial work as a pilot table to give a visible check of flotation performance.

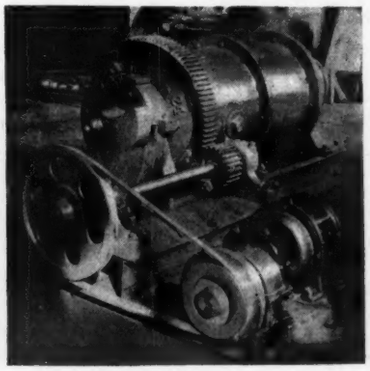
Heavy-Duty Wire Screen

Woven-wire screen of spring steel has been announced as a new development of the Ludlow-Saylor Wire Company, St. Louis, Mo. Spring steel is used, a hard, resilient alloy intended for severe service on revolving screen jackets, vibrating screen sections, and shaking or gravity screening surfaces.

Screens of this material are said to last several times as long as the same grade made of ordinary steel. The first test installation, made four years ago, is reported to be still in service. It consists of two cylindrical outside jackets on a revolving screen handling crushed limestone road ballast.

For Laboratory Crushing

A so-called ball-rod-tube mill has recently been developed by the Denver Equipment Company, Denver, Colo., for laboratory work. It can be quickly converted from any one of the three types of mills to another, and occupies only a small space. The cylinders are interchangeable and of thick, hard, cast iron. No liners are used. Discharge is of either the trunnion or grate type. Other features are roller-bearing pinions, self-aligning trunnions, and drop rings. The machine is said to be an exact duplicate of large crushers.



Three types of mill in one, for laboratory use

Personal Notes

L. D. Huntoon, of New York, is in northern Ontario.

A. D. Storke, director of Rhodesian Selection Trust, has returned to London from the United States.

J. F. Hanst, formerly chief engineer and geologist, Cleveland Cliffs Iron Company, Michigan; chief engineer, Cortes Associated Mines, Mexico; chief

J. F. HANST

mining engineer, Andes Copper Company, Chile, and for the last twelve years with the Ingersoll-Rand Company, has joined the engineering and sales staff of the Pittsburgh Valve, Foundry & Construction Company, with headquarters at Pittsburgh, Pa.

H. Heggie, metallurgist, formerly with Anaconda Copper, is now at Mount Isa, Queensland, Australia, on consulting work.

Inar Nogaarz, of the Badger mine, won the mucking contest at Butte during the recent Mines Field Day, defeating last year's champion by one second.

Alan Bateman, professor of economic geology at Yale University, has returned to New Haven, Conn., after a professional trip to British Columbia and Alaska.

E. G. Brown, metallurgical engineer, has gone to Russia as consultant to the Soviet government on ore dressing. His headquarters for the next two years will be in Moscow.

Chester F. Lee, mining engineer, of Seattle, has returned from the Mother Lode district, in California, where he examined properties for Seattle and Michigan interests.

V. Gibbs has been appointed chairman of the board of directors of Sulphide Corporation, which operates the Central mine, at Broken Hill, New South Wales, Australia.

T. de Vries, mining engineer, of Holland, recently completed six months of post-graduate work in flotation at the Montana School of Mines, in Butte. He returned to Holland on July 16.

Van Dyne Howbert, mining engineer with American Metal, has requested us to correct an item in *E.&M.J.* of July 24, in which he was erroneously called a vice-president of that company.

Guy D. Bengough and **Ulick R. Evans** are to receive the Beilby Memorial Awards for 1930, for outstanding research and achievements in metallurgy. Both are graduates of the University of Cambridge.

Prof. **R. S. Lewis,** of the mining department of the University of Utah, has returned to Salt Lake City after a four weeks' trip through the iron and copper districts of Michigan, Wisconsin, and Minnesota.

R. T. Birks and **W. S. Cherry** have been elected president and vice-president of Howey Gold, respectively, following the resignation of **J. E. Hamell,** former president of the company, which operates in Canada.

P. C. Benedict, field geologist for United Verde, recently gave a résumé of Mexico's mining and labor laws and a comparison of that country's metal output with that of the United States before the Jerome Rotary Club.

T. Forster Courthope, formerly general manager of the Retsof Mining Company, has been appointed general manager of both the Retsof company and the Detroit Rock Salt Company, another subsidiary of the International Salt Company.

Louis Ware, who has been engaged in general consulting work since his resignation last year from the superintendency of mining operations for Anglo-Chilean Consolidated Nitrate, has joined the staff of the New York Trust Company.

H. A. Guess, vice-president of American Smelting & Refining, has joined the board of directors of Mining Trust, and has been elected vice-chairman. **Preston Locke,** resident engineer for American Smelting & Refining in London, has also joined the board of this company.

S. M. Soupcoff, mining engineer, has resigned from the staff of American Smelting & Refining, in Utah, to become associated with Moore, Leonard & Lynch, New York brokerage firm. Mr. Soupcoff's resignation was effective Aug. 1. He had been with A. S. & R. at Salt Lake since 1916.

David White, chairman of the committee on fellowships, Division of Geology and Geography of the National Research Council, announces that the following have been awarded Storrow research fellowships for 1930: **H. J. Fraser,** Cambridge, Mass.; **N. Hinchley,** St. Louis, Mo.; **R. Lupher,** Pasadena, Calif.; **J. S. Smiser,** Princeton, N. J.

A. W. Dickinson has been appointed chief of the tax division of the American Mining Congress, succeeding **McKinley W. Kriegh,** who has resigned to enter private practice. Mr. Dickinson is a graduate of the Michigan College of Mines and spent several years in the Michigan copper and Wisconsin zinc-lead districts. He was also formerly valuation engineer in the income-tax unit of the U. S. Internal Revenue Bureau.

Byron M. Bird recently joined the staff of the Batelle Memorial Institute, Columbus, Ohio, to take charge of research on ore dressing and coal preparation. Mr. Bird, who had been with the U. S. Bureau of Mines for the last ten years, graduated from the University of

BYRON M. BIRD

Washington, in 1918. During the War he commanded Company D of the 547th Engineers. Later he took charge of the ore-dressing laboratory of the University of Washington, until April, 1920, when he went to the Bureau of Mines. In 1925 he was appointed supervising engineer of the Bureau's Northwest Experiment Station in Seattle. In 1928 he was transferred to Alabama, as supervising engineer in charge of the Southern Experiment Station.

Floyd S. Weimer, consulting engineer for Anaconda Copper, has just returned from Europe, where he has spent the last three years. During his stay in Europe Mr. Weimer supervised the construction and starting of the electrolytic zinc plants of Giesche Spolka Akcyjna at Katowice, Poland; Socitea de Pertusola at Crotone, Italy; and Det Norske Zinkkompani, at Odda, Norway. Mr. Weimer, who is accompanied by his wife and daughter, will join the Anaconda staff in this country.

OBITUARY

Roe W. Gifford, foreman at the Fortuna mine of Braden Copper, at Sewell, Chile, was accidentally killed recently while inspecting an ore pass. He was 28 years old, and had been with the company for the last five years. He is survived by his widow and his mother.

Victor Gardiner Hills, mining engineer, of Denver, Colo., died recently at Skouriotissa, Nicosia, Cyprus. He was 75 years of age, and for the last four years had been engineer for Cyprus Mines. During his long career Mr. Hills was connected with many mines in western United States, particularly in Colorado. He was a member of the A.I.M.E., the Institution of Mining and Metallurgy, and the Canadian Mining Institute.

NEWS OF THE INDUSTRY

Investigate New Uses for Copper Cliff Smelter Fume

Operations having been started in two out of three units of its new sulphuric-acid manufacturing plant at Copper Cliff, Ont., which utilizes the sulphur fumes from the new smelter of International Nickel, Canadian Industries is now investigating the possibility of using a greater proportion of the sulphur fumes for the manufacture of products other than sulphuric acid. Pulp and newsprint manufacturers in northern Ontario are customers for about 150,000 tons of sulphur annually. The chief drawback at present to the wholesale manufacture of sulphur from the nickel-copper smelter gases is the cost. There is now a distinct likelihood that this problem may be solved, with the result that another new branch of industry is in the offing in connection with the nickel-copper operations at Sudbury.

■

Vipond to Sink to 2,000 Ft.

A program of deep development and exploration is proposed for Vipond Consolidated Gold, south of and adjoining the Hollinger Gold mine, at Timmins, Ont. In this connection a winze will be sunk from 1,250 ft., the present bottom level, to a depth of 2,000 ft. or possibly 2,250 ft. Because of recent improvements in ore developments in the upper levels of the mine, the value of output has been gradually increasing, so that the property is now in the best physical condition in its history. Cash reserves total about $1,000,000. June output amounted to $85,500 from 9,907 tons of ore, averaging $8.63 per ton. Operating profits are currently reported at about $4 per ton on an average daily production of 300 tons. Ore blocked out is said to be sufficient for more than a year of capacity operation.

■

Sudbury Achieves City Rank

Pursuant to an act passed at the last session of the Ontario Legislature, incorporating the City of Sudbury, incorporation to become effective on and after July 28, 1930, the first city in Canada founded upon a basis connected with mining has been created. Formal inauguration of Sudbury as a city was fittingly celebrated on Civic Holiday, Aug. 4, when delegations were present and felicitations received from municipalities throughout the province.

Sudbury's history has been practically synonymous with the history of the nickel industry, as the city is the center of a field which is responsible for more than 90 per cent of the world's supply of that metal. Owing principally to expansion of the nickel industry, along with new discoveries of copper-lead-zinc deposits and a revival of prospecting, the population of Sudbury has grown from 10,302 in 1927 to 20,099 in 1930. In view of the wealth and extent of its mineral deposits, together with the diversity of its products, the new city is frequently referred to as the Butte of Canada.

■

Liberty Pit Operations to Continue, Judge Decides

Operations in the Champion and Liberty claims, in the Liberty open pit of Nevada Consolidated, near Ely, Nev., can be continued until the final pit bottom has been reached, Judge Frank H. Norcross, of the U. S. District Court of Nevada, has decided. His memorandum on the action brought by Nevada Consolidated Copper against Consolidated Coppermines Corporation was published July 31. The two companies own adjoining claims at Ely. This suit was brought by Nevada Consolidated against Consolidated Coppermines to determine their respective rights under a contract dated June 16, 1926, which among other provisions, gave Nevada Consolidated Copper the right to mine certain Consolidated Coppermines ores and gave to Consolidated Coppermines, among other provisions, the right to mine certain Nevada Consolidated Copper ores.

According to the decision, Consolidated Coppermines cannot mine underground beneath the open pit until Nevada's shovel operations have been completed down to the lowest level to which the latter chooses to carry them. Consolidated Coppermines has sunk the Emma-Nevada shaft to handle ore from its property underground and had intended mining certain tonnages through this shaft that might have caused damage to the pit or accessory workings. Extraction of this ore will now either have to be suspended pending the completion of the shovel operations or the ore will have to be mined through the open pit, if Nevada, under the terms of its contract of June 26, 1926, decides to do so.

Three of fourteen counterclaims made by Coppermines have been dismissed, but the court is retaining jurisdiction for making any order or modification in the present decree that may be considered necessary in the future. In particular, the court reserves jurisdiction to hear Consolidated Coppermines' counterclaims reserved for future jurisdiction. On the whole, however, Nevada's interpretation of the 1926 contract, made between the two companies to provide for mining orebodies contained in adjoining claims, has been accepted as correct.

■

Bonanza Cuts Ore at Bingham

A strike of high-grade lead-silver sulphide ore is reported by Bonanza Mining on its Park Bingham lease, at Bingham Utah. The strike was made 94 ft. below the Niagara level of the adjoining United States mine in what is believed to be the "B" limestone.

A. S. & R. Closes Swansea; Retimbering Ground Hog

Operations at the Swansea mine and mill of American Smelting & Refining, a few miles north of Bouse, Ariz., have been suspended indefinitely because of the low price of copper. With copper at 11c. a pound, operations at capacity would have resulted in a loss of about $4,000 monthly. The plant started operations about two months ago, handling 250 tons of copper ore daily. Recovery had been averaging about 95 per cent, with a concentration ratio of about 7:1. Average grade of ore is about 3 per cent copper.

At its Ground Hog lead-zinc unit, near Vanadium, N. M., A. S. & R. is cleaning out and retimbering the main shaft. A new electric hoist is now being installed. The steel headframe was completed some time ago.

■

Copper Canyon Reports Strike

J. C. Brumblay, manager of Copper Canyon Mining, near Battle Mountain, Lander County, Nev., reports the discovery of rich chalcocite ore on both sides of old workings. The property was operated formerly by Glasgow & Western Mining, which followed a post-mineral fault cutting through the real orebody on the Virgin vein.

■

Reopen Patriquin Quicksilver

The Patriquin quicksilver mines near Parkfield, San Luis Obispo County, Calif., have been reopened by Biddy Consolidated Mining. The Archer mine in the same district, under lease to W. F. McWaters, has been equipped with a 20-ton rotary furnace; an eleven-pipe retort furnace has been producing about 30 flasks of quicksilver a month during the development stage.

■

Plant Started in Bolivar Area

Operation of the new mill of the Compagnie Française de la Mocupia, in the Bolivar gold district, Venezuela, was started on June 1. Although rated capacity is only 50 metric tons daily, the plant, now operating full time, is handling about 60 tons. The average grade of ore crushed to the middle of July was 14 dwt. in gold per ton. The management estimates costs at about $6 per ton. Extraction of gold from the ore is estimated at about 90 per cent. Development work in the mine has been very satisfactory. About 35,000 tons has been proved and an additional 190,000 tons of probable ore is estimated. A drift west of the incline shaft has followed ore for 390 ft., showing an average width of about 6 ft.

Start New Gold Hill Plant at Round Mountain

OPERATION of the new 100-ton cyanide plant of Gold Hill Development, 4½ miles north of Round Mountain, Nev., was started on July 31, about a month ahead of scheduled time. Construction of the plant started in April. The plant is now handling ore from the mine dump, which contains about 6,000 tons taken out in development. Ore has been proved in the mine to a depth of 400 ft. and for a length of about 1,000 ft.

Albert Silver, metallurgist, of Tonopah, and H. A. Johnson, of Tonopah Mining, designed the mill, which cost about $70,000 to build. Mr. Johnson, who is now general manager of Gold Hill, superintended actual construction. J. N. Davis is now in charge of the plant. John Dynan is mine superintendent. Recovery in the new plant is expected to be about 95 per cent of an average grade of about $12 per ton. Mr. Johnson has estimated costs at $6 a ton, including loss in tailing.

After breaking the larger pieces of ore in the ore pocket and hoisting to the surface in one-ton skips, the ore is automatically dumped in the crushing plant or bin, from which it passes over a 1½-in. grizzly to a 10x20-in. Blake crusher that breaks to a maximum of 1½ in. After reduction to this size, all ore is conveyed to the 225-ton mill bin, from which it is fed to a 5x5-ft. Williamson ball mill, operating in closed circuit with a simplex Dorr classifier, and reducing to 100 mesh. While in the ball mill, the ore receives the first cyanide solution, discharging to a duplex classifier in closed circuit with a 5x18-ft. tube mill. The management expects that this treatment will crush 80 per cent to 200 mesh, but, if further classification is required, three 7-ft. Callow cones, now held in reserve, can be used. A primary thickener takes the ore from the tube mill, the overflow solution passing direct to precipitation and the pulp to a series of three Dorr agitation tanks.

As the ore is free milling, about 70 to 80 per cent of the gold is expected to be recovered in the grinding circuit. Pulp from the Dorr agitators will go to a Dorr thickener and then to an Oliver filter, after which it will be discharged into a log washer before being sent to the dump.

Overflow from the primary thickener will pass to a gold-storage tank for precipitation and then to a shallow tank equipped with filter leaves for clarification. After treatment in Mills-Crowe equipment, the precipitate will be sluiced to a clean-up tank with canvas filter bottom and dried for the bullion furnace, of the same type as that at the Millers plant of Tonopah Mining. All equipment in the mill is electrically driven.

Gold Hill Development was formed by officials of Tonopah Belmont Development and Tonopah Mining to take over the property, consisting of thirteen claims, from C. W. Taylor and E. H. McMurray. The company has 2,000,000 shares of $1 stock, of which 720,000 shares were issued to the original owners. The main shaft, 325 ft. deep, was sunk to 400 ft. and electric power obtained from Round Mountain. Development has been centered mainly on the 225 level, where officials state the orebody is 1,000 ft. long, with the east face still in ore. On the 400 level, a heavy water flow 415 ft. east of the shaft has handicapped operations. As sufficient ore is in sight above the 225 level to operate the present plant for a considerable time, only a 500-g.p.m. pump has been installed to keep water below that level.

■

Quincy Now on Two Shifts

Quincy Mining has about reached the end of its extensive underground opening program in Michigan, and two shifts instead of three now are employed. Quincy is in position, when the metal market improves, to increase production as required. With about 10 miles of new openings in the bottom levels of three shafts, the retreating system of stoping from the end of drifts back toward the shaft can be adopted. This will make for safer and more economical mining, and provide ample supports for the mine as it goes deeper. W. Parsons Todd, of New York, president of Quincy, is visiting the properties of the company.

■

Mining Corp. Aids Abana

Mining Corporation of Canada has loaned $50,000 to Abana Mines, with which that company can continue payment for its property in the Rouyn district of Quebec. About $250,000 additional will probably be required to put this copper-zinc property into production and to provide necessary working capital. A 250-ton mill is now under construction. What participation Mining Corporation will take in Abana affairs hereafter has not been made public.

New 100-ton plant of Gold Hill Development, three days before operations started, with construction materials still in evidence in the foreground

Senate Committee Starts Silver Investigation

Hearings in the Senate's investigation of the silver situation are tentatively scheduled to open in Washington on Aug. 8. Further hearings probably will follow in the mining centers. No itinerary has been arranged, but Senator Pittman's subcommittee is expected to visit Denver, Los Angeles, Spokane, Seattle, and Reno. The object of the committee's inquiry is to determine what action may be taken by the United States government to stabilize the price of silver.

Reduction in the size of the silver dollar and half-dollar is proposed by Senator Oddie, of Nevada, as a means of restoring the popularity of these coins and thus increasing the demand for the white metal. The new silver dollar would be only slightly larger than the present half dollar, and the new half-dollar would be of a size somewhat larger than the quarter. No change is proposed in the size of the last-named coin.

Senator Oddie believes that the wider use of silver coins resulting from the reduction in size would more than offset the decrease in silver content. He argues in support of his proposal that the new paper currency was introduced primarily as a measure of economy and that inducing the public to use coins more freely would result in even greater economy, as the depreciation in paper currency is much greater than the loss from abrasion of silver coins.

■

Survey Studying Minerals in Many Western Areas

Mineral studies under the U. S. Geological Survey are progressing over large areas in several states during the current field season. In Colorado, co-operative work is being carried out more extensively than ever, with large-scale topographic maps being made in the Nederland Tungsten, the Sugarloaf, and the St. Kevin districts, near Leadville, and also in the Rico district. The Snowmass and Mount Powell quadrangles are being mapped at the usual scale of 1 in. to the mile. Geological studies will be made with most of these this year and also in the Jamestown, Mosquito Range, and Ouray regions, with brief examinations in other districts. In New Mexico, the Magdaline district survey is to be completed.

Nevada studies are continuing near Mina and Tybo. The Tonopah district is being remapped. A geologist is revisiting Contact, Nev., and several other districts in the eastern part of the state, the trip including the Carson Sink country. Reconnaissance studies are under way in south-central Idaho. The Bayhorse quadrangle will be finished this season. In California, the deep developments in the Grass Valley mining district are being investigated.

In Oregon, several parties are working for a second year on a large co-operative program. In the western part of the state the Bohemia gold district, the Black Butte quicksilver district, and the Takilma copper district are being surveyed. Several mining districts in eastern Oregon in the vicinity of Baker are being covered by two parties, and a geologist is working on the more important non-metallic resources of the entire state.

Success of Bingham Prospect Upsets Established Geological Theories

New Area Opened Up in Bingham District of Utah—Congor Tunnel Affords Better Shipping and Development Facilities for Silver-Lead-Zinc Property

GAIL MARTIN
Special Utah Correspondent

NORTH of the proved area in the great mining camp of Bingham, Utah, —which has produced about $915,000,000 since its discovery by General Connor's soldiers in 1865, lies the Bingham Prospect, newest producing mine in the district. Development of this property involved several features worthy of consideration. Preconceived theories concerning the geology of virgin territory have been upset and the limits of the Bingham district's productive area have been greatly extended.

In addition to the value of the scientific data obtained, discovery of ore on Bingham Prospect ground supplies another interesting and stimulating example of the need for persistent effort in mining. Work was started in 1880 by pioneer prospectors and was continued in a desultory manner at intervals until the present enterprise was started. The early miners frequently reached points close to the deposit now being exploited. That they failed to find it is hardly to their discredit, since, notwithstanding improved facilities for mining and the greatly augmented knowledge of geology now available, several years and a considerable expenditure of money were required to investigate numerous promising leads before the present operators followed one to the high-grade orebody from which shipments have been made.

Though differing widely in the geology of its ore deposits, exploration at Bingham Prospect resembles in several points the exploration work done at Tintic Standard and Park Utah. Here, too, the ground lay beyond any known ore deposits. The main characteristics of subsurface geology were masked by a flow of igneous rock, thus greatly complicating exploration.

Two favorable factors determined the operators to start exploration: (1) The Bingham Prospect ground lies on the great east-west Bingham-Park City anticlinal fold, extending through the Wasatch and Oquirrh Mountains, in northern Utah. (2) Under geologic conditions similar to those believed to exist in the Bingham Prospect holdings, large orebodies had been developed at the northeastern end of the district by Bingham Mines.

The limestone replacement orebodies of the Bingham district occur in limestone beds in the Weber or Bingham quartzite, of Upper Carboniferous age. These ore horizons are known as the Jordan or Highland Boy, the Brooklyn or Commercial or Yampa, the Lark, and others of lesser importance. The limestones and quartzites were compressed, folded, and intruded by stocks and dikes of monzonite porphyry. Volcanic flows later covered the sedimentaries northward, toward the Salt Lake Valley, with andesite.

Bingham Prospect is an unincorporated organization operating three claims on which most of the development work described in this article has been done and from which all the ore mined to date has been extracted. Surrounding these claims are the holdings of Lead Silver Mines, extending along the strike of the limestone beds for about 1½ miles. Lead Silver Mines is a closed corporation, owned by the same interests as Bingham Prospect. The two properties have been operated jointly. They lie in an intensely fissured and mineralized zone, believed to extend from the Utah Copper stock. These fissures, cutting not only the sedimentaries but the igneous rocks, can be seen on the surface. Their strike is directly toward the Utah Copper open pit. Surface mineralization is so pronounced that old-time prospectors started sinking on a quartz outcrop, just a few hundred feet from the present main shaft. Some gold-bearing quartz was extracted, but production was insignificant.

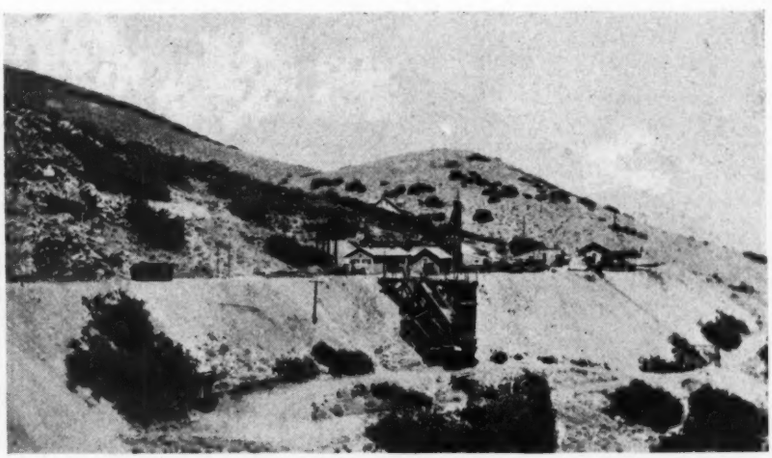
Portal of the Congor tunnel at the Bingham Prospect property

Since the first important ore find in May, 1928, development has demonstrated the sound judgment of the pioneer operators. Had the deposit been followed through the several fault displacements, they would have cut the high-grade orebody from which production has largely come within 150 ft. of the surface. This deposit, which has shipped higher grade ore than any other Bingham mine in recent years, produced 27,552 tons of ore in 1929, which yielded 177,178 lb. of copper, 6,596,042 lb. of lead, 4,018,788 lb. of zinc, 1,005,898 oz. of silver, and 1,159 oz. of gold. Three types of ore have been shipped: siliceous ore, carrying 0.62 per cent lead, 0.2 per cent copper, 19.7 oz. of silver, and 0.038 oz. of gold to the ton; sulphide ore, carrying 10 per cent lead, 9.6 per cent zinc, 0.37 per cent copper, 34 oz. of silver, and 0.03 oz. of gold to the ton; and oxide ore, carrying 17.1 per cent lead, 2.5 per cent zinc, 0.3 per cent copper, 27 oz. of silver, and 0.058 oz. of gold to the ton.

Development at Bingham Prospect was started with the intention of exploring the Lark limestone, an 8- to 12-ft. bed occurring in the quartzite that separates the Commercial and Jordan limestones, each about 300 ft. thick. At the Bingham Mines property, the Lark limestone was so thoroughly replaced in certain zones that it appeared to be a vein, not a bedded deposit, lying between the quartzite walls. For this reason, attention at Bingham Prospect was first directed to this horizon, although the Commercial limestone carries ore at Utah-Apex and the Jordan limestone carries ore in the United States and Highland Boy mines.

At the Bingham Prospect, the limestone beds were believed to have a general north-south strike and a dip to the west, as in the proved ore-bearing areas of the camp. Development proved that faulting and thrusting had cut and shifted the sedimentaries so that the strike was east-west rather than north-south. The quartzite separating the Jordan and Commercial limestone was not found, giving the management of the company basis for the theory that faulting had removed it, as well as about 200 ft. of the quartzite.

When hope of striking ore in quantity had sunk to a low point, a strike was made on the 200 level in an ore channel



Surface plant at Bingham Prospect, through which ore was formerly handled

New loading station near the Congor tunnel portal at Bingham Prospect, which will permit direct loading from mine car to railroad car

that reaches the surface as a chimney in one of the main fissures. Within a few months of the date of the first shipment, in June, 1928, the mine had returned the original investment. Three carbonate stopes were speedily opened, producing ore which averaged 15 to 20 per cent lead and 25 oz. of silver to the ton. In places, two or three sets wide, the ore carried 40 per cent lead and 100 oz. of silver to the ton. At 260 ft., the orebody was 20 ft. thick, 40 ft. wide, and 300 ft. long.

Ore deposition resembles that at Tintic more than that at Bingham. The orebodies consist of pipes and shoots occurring in favorable horizons at their intersections with fissures or at the intersection of a fissure with other vertical cross fissures, flat fissures, or contacts. Replacement occurred in fractured quartzite at the base of the Commercial limestone, a condition hitherto unknown in the Bingham district. Although development has not yet struck the Lark limestone at Bingham Prospect, Bingham Mines has opened ore in this member on the Mascotte tunnel level, 300 ft. below the 500 level of Bingham Prospect, indicating that this horizon may be entered at depth, where its ore possibilities may have an important bearing on future production, the management believes.

Bingham Prospect orebodies follow the dip of the beds and the strike of the mineralizing fissures. The deposit, one of the most uniform and concentrated found in Bingham during the last few years, has been followed for 2,000 ft. on its rake. On the lowest levels, the ore is continuing of good grade. In the "555" winze, one of the lowest workings, the Copper fissure contains an orebody 6 to 8 ft. wide and 40 ft. long about 30 ft. below the base of the Commerciai limestone. In the Soupcoff winze, also below the 500 level, the Copper fissure is mineralized for 80 ft. in the hanging wall of the Jordan limestone. The ore assays 15 per cent lead, 15 per cent zinc, and 20 oz. of silver to the ton.

Connection of the Congor tunnel, nearly a mile long, with the 500 level and the "555" winze has recently been completed. This tunnel was extended to furnish an outlet from the 500 level, where most of the prospecting had been done, to the Denver & Rio Grande Railroad. Ore can now be dumped directly into railroad cars at a saving of about $2 a ton. This tunnel, 5x7 ft. in the clear, was driven 1,900 ft. to connect with the old workings by J. Fred Johnson and John Mays at a total cost of less than $10 per foot. It has been equipped for electric haulage. Two General Electric four-ton locomotives are used on a 24-in. gage track, of 30-lb. rails. One locomotive is equipped with a 300-ft. reel for running into side drifts. Mine cars of the U. S. side-dump type, having a capacity of three tons and made by the Davis Sheet Iron Works, of Salt Lake City, are used.

From the new tunnel, 2,500 ft. north of the old workings, the company is now drifting toward the Jordan limestone on a barite fissure with the intention of cutting three east-west fissures showing on the surface. This work is being done at a labor cost of about $6 a foot. Progress is averaging 200 ft. monthly.

Equipment at Bingham Prospect includes three Ingersoll-Rand compressors, one with a capacity of 1,440 cu.ft. per minute and the other two, 300 cu.ft. per minute. The large compressor is driven by a 200-hp. General Electric synchronous motor. On the surface the plant includes a timber-framing shed and carpenter shop, a boarding house with living accommodations for 42 men, change rooms, superintendent's residence, and offices. The blacksmith shop is equipped with a Sullivan oil-burning furnace and a Gardner-Denver drill sharpener. At the collar of the "555" winze, an F. M. Davis hoist, capable of reaching to a depth of 900 ft., has been installed. It is driven by a 40-hp. General Electric motor.

I wish to acknowledge indebtedness for the information contained in this article to J. A. Hogle, one of the owners of Bingham Prospect; George F. Stott, mine superintendent; and J. J. Beeson, consulting geologist, of Salt Lake. who made the first report on the properties and recommended development of the ground.

■

Park City Con. Raises Tonnage Shipped From Development

Production of silver-lead ore from development work done by Park City Consolidated, on its property at Park City, Utah, has been increased to 100 tons daily. No stoping will be attempted until metal prices improve, according to J. J. Beeson, general manager of the company. Development ore comes from the 800 and 900 levels. A 3-mile railroad spur is being completed to the property from Park City.

Park City Con. is deepening its winze from 1,000 ft. Stations will be cut every 100 ft. of vertical depth to explore the vein. On the 800 level, ore has been proved for 400 ft. over an average width of 3 ft., according to Mr. Beeson. On the 900 level, ore has been proved for 300 ft., with an average width of 5 ft. Raises are being put up between the two levels at intervals of 100 ft.

U.V.X. Starts New Mill; Reduce Tax Valuation

Operation of its new 200-ton flotation plant at Clemenceau, Ariz., has been started by United Verde Extension, according to J. S. Douglas, president of the company. The plant is used to reduce the silica content in some of the upper level sulphide copper ores, resulting in a less siliceous furnace charge. About 80 tons of concentrate will be produced daily by the plant. Production of the company has been reduced as a result of the drop in the price of copper from an average of about 5,000,000 lb. to 3,500,000 lb. monthly. No developments of importance have transpired in the mine at Jerome. Development of the Golden Anchor property in Idaho is being continued.

In an opinion handed down in the Yavapai County Superior Court at Prescott, on July 19, Judge F. W. Fickett reduced the assessed valuation of the U.V.X. property from $14,812,440 to $5,710,000, as of June 15, 1929. The higher valuation was that fixed by the State Tax Commission. The reduction resulted from action brought by the mining company against the tax commission, the State Board of Equalization, and Yavapai County, because it believed its assessment too high. In his opinion, Judge Fickett stated that evidence showed the life of the mine from Jan. 1, 1929, was from three to six years, depending on the amount of ore extracted annually. During the trial, attorneys for the defendants fixed the current value of the mine at $8,606,405, on the basis of 18.1c. per pound of copper for 1929 production and 16c. per pound for all to be produced thereafter. Based on a ten-year average price, however, the court decided 15c. per pound was a fair figure to determine the value of all copper extracted from the mine after Jan. 1, 1929.

■

Royal Development Building 200-Ton Flotation Plant

Construction of a 200-ton flotation plant on the Royal Development copper property, in the Leavenworth mining district, Chelan County, Wash., is now under way. The plant is being built to permit increasing capacity to 450 tons, and then 1,000 tons daily, as the mine is put in condition for handling larger tonnages, according to James Naughten, president and general manager of the company. Development on the orebody now being prepared for production has indicated 5,000,000 tons of copper ore, Mr. Naughten estimates. Mineralization has been indicated for a distance of 7 miles from the Trinity Tunnel, which was driven about 2 miles to cut the orebody.

In the coarse-crushing unit of the concentrator, equipment includes a 15x30-in. jaw crusher and a 4-ft. Symons cone crusher. Ore-bin capacity is 500 tons. The fine-grinding unit includes an 8x4-ft. ball mill, Dorr classifier, flotation cells, thickener, and an American filter. All equipment will be driven by individual motors with remote control, thus requiring only one operator for each unit per shift. The company is developing its own hydroelectric power for mining and milling purposes, but will also maintain a Diesel engine in reserve to insure continuous operation when the water is low.

Manganese Producers Ask Ban on Russian Imports

An embargo on imports of Russian manganese ore into the United States, similar to that temporarily laid on imports of pulpwood, has been asked by the American Manganese Producers' Association in a letter to the Congressional committee investigating Soviet activities in this country. Senator Tasker L. Oddie, Nevada, has also taken the matter up with Seymour Lowman, Assistant Secretary of the Treasury, but there seems little likelihood that an embargo will be laid, as the ban on pulpwood has since been lifted and President Hoover has publicly stated that an embargo should be resorted to only in specific cases where the use of convict labor can be proved definitely.

J. Carson Adkerson, president of the manganese association, charged that convict labor was employed in producing the Tchiaturi manganese, which forms the bulk of the Russian exports, and that the Russian government was forcing its production into the United States market by cutting prices below production costs. As a result, Mr. Adkerson stated, American manganese producers were being forced to suspend operations. In reply to these charges, which were also made by Senator Oddie in his letter to Assistant Secretary Lowman, A. V. Mikadse, of the Soviet Manganexport Corporation, stated that Russian manganese ore was being sold in this country at world market prices plus import duties. He pointed out that Russian manganese has been imported since 1886 and denied the allegation that slaves and convicts are used at the mines. At Tchiaturi the minimum wage is 84 rubles a month, he declared.

Imports of Russian manganese this year to the end of May totaled 65,116 tons, manganese content, valued at $1,416,145, compared to 53,490 tons, valued at $1,969,546, in the corresponding period of 1929. Totals for last year were 169,121 tons, valued at $5,452,366, a result of increased takings later in the year.

■

Porter-Idaho Starts Shipping

Premier Gold has made its first shipment of silver-gold ore from the Porter-Idaho mine, also in the Portland Canal district, of British Columbia. The shipment amounted to 250 tons. Although Premier does not own a controlling interest in Porter-Idaho, by an arrangement with Clay Porter for voting rights on his stock for five years, Premier controls the operations. The new rope tramway, which Premier built, belongs to Porter-Idaho. Premier is paying $1 a ton for all the ore from its Prosperity mine shipped over it. Profits from operation of Porter-Idaho will be turned over to Premier, until the cost of development and equipment has been reimbursed.

■

San Antonio May Get Mill

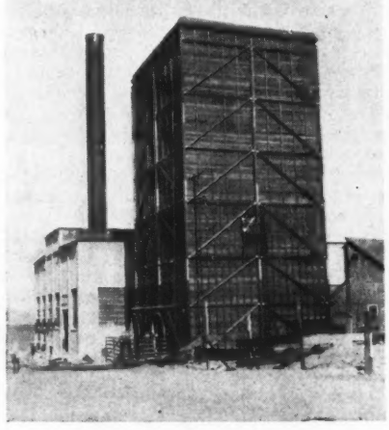
Following a recent examination of the San Antonio gold mine, in southwestern Manitoba, J. A. Reid, the consulting engineer, has recommended construction of a 100-ton mill. The No. 1 three-compartment shaft will probably be deepened to 950 ft. to connect with the workings at that depth. If this program is carried out, electric power will probably be obtained from the Central Manitoba station, 17 miles distant. Ore at the property is of good grade, but it occurs in rather narrow shoots.

■

C. & A. Completing Concreting of Campbell Shaft

Calumet & Arizona Mining is completing the concreting of the new Campbell shaft at its copper properties in the Bisbee district of Arizona. The shaft has already been concreted from the surface to the 1,600 level and from the 2,200 to the 2,300 level. A crew is now at work on the remaining section of the shaft. Installation of the new surface plant, which includes an Allis-Chalmers double-drum hoist, driven by a 1,350-hp. a.-c. motor, has been completed. The ore-receiving bin at the 125-ft. headframe is an all-steel structure, equipped with pneumatic discharge doors that permit direct dumping of ore into standard-size railroad cars for shipment to the smelter at Douglas.

At the Junction shaft, the new power plant is now in operation, and the old plant is being rapidly dismantled. Installation of spare steam-driven auxiliary machinery insures continuous operation even in the event of a power cut-off. The plant includes two 750-hp. Walsh & Weidner boilers, delivering steam at 350-lb. pressure, with 250-lb. superheat, to a 3,750-kva. Westinghouse turbine. Three



The new Junction power plant of Calumet & Arizona

Sullivan angle-compound compressors, of 4,400 cu.ft. capacity, driven by a 750-hp. Westinghouse motor, furnish air for mine and surface operations.

At the Douglas smelter of the company, about 50 per cent of the modernization program of the company is expected to be completed within a few weeks. Four additional ten-hearth Nichols Herreshoff roasters are being installed, as well as an entirely new brick flue system to connect these roasters with the acid plant. This installation will make the remaining 24 roasters available for smelter operations only. Three large Peirce-Smith horizontal converters have been installed in the place of the former Great Falls-type converters.

C. & A., like Phelps Dodge, has signed a contract for natural gas to be used as fuel at its Douglas smelter. The company now expects the new pipe line, which is being laid from the Texas oil fields, to enter Douglas by March 1.

Trepca Plant Completed Now Being Tested

Completion of the new lead-zinc concentrator of Trepca Mines at the Stantrg property, in Jugoslavia, has been announced. Units of the plant are now being tested and regular production will start in August, about a month ahead of scheduled time. The plant has a capacity of 500 metric tons of ore daily, the average grade being about 11.5 per cent lead, 10.5 per cent zinc, and 3 oz. silver per ton.

From the Stantrg mine, levels are now being extended to cut the Meljenica and Trepca orebodies on adjoining territory. Additional ground has been optioned by the company. Four engineers of the Elbof Geophysical Company are now engaged in surveying the property with electro-magnetic equipment. About $1,500,000 has been spent in opening up the Jugoslavian properties of the company to date.

■

Government Subsidy Results in Reopening Mansfeld

Reopening of the Mansfeld Copper mines, largest producers of the metal in Germany, was undertaken the last week in July, after a suspension of more than seven weeks. Failure of the company and its employees to reach an agreement on a wage cut, following the drop in the price of copper in April, resulted in closing operations on June 1. The company wanted to make a 15 per cent reduction in wages. A compromise cut of 9.5 per cent has been agreed to, but the German government will subsidize the company to the extent of 500,000 marks a month.

Because of the recent drop in the price of silver, cost of production has increased, and without a subsidy the company's operations would have to be conducted at a loss. The government considers payment of a subsidy more profitable than handing out doles to several thousand unemployed workers. Copper production in 1929 was 22,893 metric tons.

■

Nugget Starts Gold Rush

Discovery of a large gold nugget at Tarnagulla, Victoria, Australia, about 40 miles from the old camp of Bendigo, has started a new gold rush, according to Associated Press reports. About 250 prospectors are said to have reached the field already, most of them in automobiles. The gold nugget found is said to have yielded about 30 oz., or $6,000. Government aid is given to prospectors in Victoria by a subsidy of 6s. 8d. for each £1 spent in prospecting.

■

A. S. & R. Ships From Estelle Mine

American Smelting & Refining shipped a total of 425 tons of silver-lead ore from its Estelle unit, in the Cerro Gordo district, Inyo County, Calif., during June. The company operates the adjoining Estelle and Cerro Gordo mines. The shipments, which go to the Selby smelter, averaged about 50 per cent lead and 38 oz. of silver per ton.

Trend of the Times

EXACTLY a year after business scaled the peak of its 1929 boom it is reaching its low in the subsequent depression. . . . The *Business Week* index has dropped again, from 94.4 per cent of normal to 91.1 per cent, as compared with the high point of 114.6 per cent a year ago, and will probably fall farther. . . . August will bring definite signs of improvement, beginning with the basic industries, and as we move further into the last half, the paralyzing pessimism of recent months will find less to feed on in the comparative records of this year and last. . . . Although the usual seasonal decline of building contracts has set in rapidly, abundant security issues for public and private work in the past quarter will cushion the decline, and the contracts placed so far will carry over into the business activity during the rest of the year. . . . While general trade is beginning to sag under the pressure of months of impaired purchasing power and business confidence, industrial activity and railroad movement of merchandise show signs of revival under the stimulus of depleted stocks, and non-agricultural commodity prices are strengthening.—From *The Business Week* of August 6.

A. S. & R. Has Utah Holdings Surveyed From Air

An aërial survey of the American Fork holdings of American Smelting & Refining, 40 miles south of Salt Lake City, Utah, is being completed by the Aerophotograph Company, of Washington, D. C. At its Yankee property, in Mary Ellen Gulch, A. S. & R. is continuing extensive development. Several raises are being put up to the productive limestone formation. A new 550-cu.ft. air compressor has been installed. L. B. Birch is superintendent of the property.

Diamond drilling has started on the company's Silver Creek properties, in Park City. At the East Utah mine, underground work is being continued to correlate data obtained in a geophysical survey. The company has also started underground work at the Frisco Lulu mine, in Beaver County.

■

Lake Shore Output at New High

Returns for Lake Shore, at Kirkland Lake, Ont., for the quarter ended June 30 indicate the plant handled 120,000 tons, from which was recovered $2,000,000, an average of $16.66 a ton. This production will establish a new high record in the history of the mine and indicates a total production of about $6,600,000 for the year or an average recovery of $14 a ton. The addition to the mill, which will raise the tonnage to 2,000 tons a day, is expected to be in operation in September.

■

To Ship Flux to McGill Smelter

About 50 tons of flux ore, carrying about $6.50 in gold a ton, will be shipped daily by Smokey Development from Lane City, Nev., to the McGill smelter of Nevada Consolidated Copper. A 400-ft. tunnel, which will enable cheap mining of a considerable tonnage of this ore, has been completed as well as loading equipment and an ore bin at the railroad.

Boleo Exploring Area South of Present Workings

Development at the Boleo copper property, in the State of Lower California, Mexico, is being centered on an area south of the present mine workings. Results to date have been relatively encouraging and have pointed to the existence of a deposit of considerable tonnage. It is not sufficiently large as yet, however, to justify equipment to replace the present Montado workings, which are nearly exhausted. Decision will rest largely on the results of further equipment. Exploration in the Infierno level, north of the mines, has been suspended because of failure to encounter interesting mineralization.

In 1929, Boleo mined 311,800 metric tons of ore, averaging about 3.81 per cent copper, from which 11,600 metric tons of the metal was produced. The company has granted an option on its D'Inguaran copper property, in Michoacan, to American Smelting & Refining. The option calls for $50,000 to be spent in development work annually for a period of three and a half years.

■

San Francisco Mines Increases Daily Tonnages to 1,000

San Francisco Mines of Mexico, operating in Chihuahua, Mexico, is now handling about 1,000 tons daily, compared with an average of about 850 tons daily last year. Capacity is being increased to 1,350 tons daily by construction of an additional concentrator unit. The lead content of the ore at San Francisco has been rising steadily, so that output of lead concentrate is now greater than of zinc concentrate. In its last fiscal year, the company produced 45,002 tons of zinc concentrate and 37,861 tons of lead concentrate. June production indicates a rate of 43,000 tons of zinc concentrate and 49,000 tons of lead concentrate annually. Profits have been greatly affected by the drop in the price of the metals. In June the operating profit was estimated at $25,269, compared with more than $120,000 in June, 1929.

Mexican Government Acts to Aid Mining Industry

Mining companies operating in Mexico may cut their working forces 50 per cent without applying to the government for permission, as the result of an announcement made by the Department of Industry, Commerce, and Labor to mining inspectors. Up to the present, the government's sanction has had to be obtained for all changes in wages, number of men employed, or working hours per week. Inasmuch as governmental action is not forthcoming immediately, at times, those mining companies that have been most adversely affected by the current depressed metal market have been at a handicap when desiring to curtail operations.

The new provision is intended to prevent complete suspension of operation wherever possible. Several large mines have recently applied for permission to shut down completely, but the government has hesitated to approve, fearing to add to the bad unemployment situation. By cutting working forces in half, mining companies will be able to minimize or nullify present losses, the government believes, although it advocates rotating the workers on a part-time basis rather than complete discharge. Where workers are discharged, they must be given thirty days' notice and fifteen days' pay if employed for more than one year, or ten days' pay if employed for less than a year.

Up to the present, because of the delay in obtaining governmental action, most of the readjustments in Mexican operations resulting from current low metal prices were reached by mutual agreement between the workers and the management of the mines. In such cases, the governmental approval was obtained later. Thus, at Guanajuato Consolidated Mining & Milling, a five-day week is now in force instead of the six-day week formerly used, and output has been cut from 10,000 tons of silver-gold ore monthly to about 8,000 to 8,500 tons monthly. This company may take advantage of the new provision and cut its tonnage to 5,000.

Although curtailment has been adopted by most of the mining companies, in some of the camps production is being maintained or increased in the belief that the drop in the price of silver, at least, is fairly permanent. This is particularly true of the Pachuca district, State of Hidalgo, where silver is the only important product and output has not yet been affected by the lower price. Santa Gertrudis, second largest producer in the camp, has maintained its tonnage at about 1,500 tons daily. Although figures on metal output are not released monthly, the profit in June of $87,312, compared with about $120,000 at this time a year ago, indicates either that higher grade ore is being mined or that costs have been greatly reduced.

■

Texas Antimony Smelter Started

Operation of a new antimony smelter at Laredo, Tex., has been started by Republican Mining & Metal, subsidiary of Cookson Lead & Antimony. This smelter is the only plant producing antimony in the United States. It supplants the smelter at Wadley, San Luis Potosi, Mexico, which the company operated for many years. The Laredo plant will treat Mexican and United States ores.

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

North Broken Hill Stops Recovering Zinc in Ore

Melbourne, July 28. — The zinc section in the flotation plant of North Broken Hill, in New South Wales, was closed on July 22, and the company is no longer making any effort to recover the zinc content of its ore, because of the present low price of the metal. Tailing from the lead-flotation plant is being pumped underground for use as filling. The men that were employed in the zinc-flotation section have been transferred to other positions on the surface, and employment is being rotated so as to afford all workers some income. In the year ended June 30, 1929, North Broken Hill produced 70,160 long tons of zinc concentrate, the largest tonnage of any Broken Hill mine.

. . . . Expiration of the Board of Trade contract for zinc concentrate, through which the Broken Hill companies have sold their output since the World War, is the reason for suspension of zinc recovery at North Broken Hill. A total of 200,000 long tons of zinc concentrate, purchased under this contract, is still stored at Broken Hill. Three-quarters of this tonnage will be shipped to the Risdon plant of Electrolytic Zinc and the remainder will go to Europe, under an arrangement recently made by Electrolytic Zinc and Imperial Smelting.

. . . . Zinc Corporation, third largest of the Broken Hill lead-zinc producers, reports a net profit for the year ended Dec. 31, 1929, of £246,050, a drop of only £9,000 from 1928. Of the profit, £137,156 resulted from mining operations and the remainder was from investments. Gross profit for June, 1930, has been estimated at about £18,000, or at the rate of £216,000 annually.

. . . . The Tasmanian government has announced completion of a contract with Electrolytic Zinc calling for the providing of 10,000 additional horsepower for the company's Risdon plant. This will be available on April 30, 1931, and will be used for the extension to the plant now being built. Capacity will be 70,000 tons annually, compared with present capacity of 53,000 tons annually. The company's annual dividend has been reduced from 12 to 8 per cent.

. . . . With the intention of providing sufficient oil for the central power plant they are now constructing at Broken Hill, the three large mining companies—North, South, and Zinc Corporation—together with Electrolytic Zinc, have floated Shale Oil Investigation, Ltd., which has a capital of £100,000. The retort shale distillation and oil-refining plant at Newnes, New South Wales, has been taken over, as well as 10,000 acres of oil-shale land in the vicinity. The plant has been idle since 1923. According to report, the new company also owns 32 miles of railroad from the plant to Newnes Junction. All phases of production of oil from shale will be investigated. It is estimated that the company's leases contain 20,000,000 tons of shale, with oil available for extraction varying from 70 to 120 gal. per ton. The seams of shale, lying between sandstone, vary from 1 to 4 ft. in thickness. In the past this condition has entailed such heavy mining costs that treatment was uneconomical.

. . . . Taking crude oil as worth 2.5d. per gallon at the plant, the shale is worth about £1 per ton. For three years, however, the Commonwealth government has promised a bounty starting at 3.5d. per ton and decreasing to 1.5d. per ton with increasing production. At the start, output will be 100 tons of crude oil daily.

. . . . An extensive alluvial gold area on the Batavia River, in northern Queensland, has been optioned by Guinea Austral, a company originally formed to operate in New Guinea. Guinea Airways, Ltd., has ordered a tri-engined Junkers monoplane for transportation of supplies for New Guinea Goldfields, subsidiary of Mining Trust.

. . . . All dredges operated by the companies of the Alluvial Tin and Austral Malay groups, in Malaya, have suspended operations indefinitely. The entire tin industry in the Federated Malay States is greatly depressed, but with the program of suspension advocated by the Tin Producers' Association being adopted so freely, hope is held for the future.

. . . . Another sensational discovery is reported from Central Australia. At Barrows Creek, about 100 miles northeast of the Jervois Range, where silver-lead deposits were found in 1929, a copper-lead outcrop has been traced for a length of a mile over an average width of 34 ft. at the surface, according to reports.

■

Important Strike at Wiluna; Edjudina Ore Assays High

Kalgoorlie, Western Australia, July 30.—A crosscut north of the main shaft at Wiluna Gold, near Meekhatharra, has cut 26 ft. of ore in the West Lode that assays 70s. in gold per ton. The lode has also been cut at 450 ft. and drifting is now under way. This orebody had previously been developed to a depth of only 300 ft. and its average grade had been about 35s. in gold per ton. Installation of the power plant at Wiluna is progressing favorably. A majority of the Diesel engines have been installed.

. . . . Crushing of the 116 tons of ore forwarded from the Kimberley Oil option on the new Edjudina gold discovery, which has been named the Patricia, has yielded 222 oz. of gold, or almost 2 oz. per ton. This discovery, made early in the year, is the most sensational in Western Australia in several years. The outcrop has been stripped to a depth of about 6 ft. and has been traced for a considerable distance. It has been proved to be gold-bearing over a length of about 1,000 ft. Development at depth will now be undertaken at a cost of £10,000. Edjudina is about 120 miles northeast of Kalgoorlie.

. . . . Returns from Golden Horseshoe show a profit of £2,950 from the operation of its new tailing re-treatment plant at Kalgoorlie in June. These results exceed expectations. They indicate that the entire cost of the plant, £35,000, may be earned in the first year of operation. As the tailing to be re-treated is estimated at about a four years' supply, a neat profit is anticipated. The 150-ton pilot flotation plant of Lake View & Star is now operating at capacity.

■

Improvement at Randfontein Gives Hope of Dividend

Johannesburg, July 29.—Probably the most encouraging factor on the entire Witwatersrand area at present is the remarkable improvement being shown by Randfontein Estates, largest producer in the West Rand district. This property, which stands second only to Crown Mines in tonnage of ore handled, has long been saddled with heavy debenture charges. Combined with the low grade of the ore, and the narrow margin of profit, they have prevented the payment of dividends since 1925. In 1929, although the property produced 2,528,000 tons of ore and 595,249 oz. of gold, the grade was only 4.7 dwt. gold per ton and the margin of profit 2s. 1d. Operating profit in the year last mentioned was £269,066.

. . . . A slight improvement in grade to 4.9 dwt. per ton, and an increase in the tonnage handled from 210,000 to 225,000 tons a month, has been sufficient to increase profits to £35,000 monthly, or at the rate of £420,000 a year. Further improvements are expected, and, as a consequence, the company's shares, which have sold as low as 4s. 6d. within the last year, are now quoted at more than 8s. On the basis of present profits, the entire debenture issue can be paid off and the payment of dividends can be resumed within three years.

. . . . The necessity of effectively meeting native labor requirements of the gold mines is again emphasized, particularly since the number of "boys" obtained from Portuguese East Africa shows a steady decline as a result of the agreement reached with that colony. An important report has been issued by the Inter-Departmental Committee of the Union of South Africa government, dealing with the Union's labor resources. This report strengthens considerably the mining industry's claims for governmental co-operation.

. . . . An international conference on miners' phthisis, or silicosis, will start here on Aug. 13. It has been arranged for by the International Labor Office in Geneva and will be attended by representatives from many countries.

Bolivia's Mining Industry Almost at Standstill

La Paz, Bolivia, July 26.—The general mining situation in this country, which is virtually dependent on the tin industry, is still very bad. Hopes for improvement must rest on an improvement in tin prices. Nearly all the smaller mines in the country have shut down and the larger properties are operating on a reduced basis—not only because they are anxious to reduce stocks of the metal, but because depletion of their ore reserves when prices are as low as they are now seems hardly justified. The tin dredge at Huanuni, which was put into operation early this year, is now working at two-thirds of its rated capacity of 120,000 cu.yd. monthly. The grade is about 2.5 lb. of tin per cubic yard of gravel.

. . . . Some renewed activity is being shown in prospecting for placer gold in the Santa Cruz district and in southern Bolivia.

■

Open Large Copper Deposit in Uganda Concession

London, July 31.—At the Kilembe property, discovered by Tanganyika Concessions on the flank of Ruwenzori Mountain, in Uganda, eastern Africa, development has indicated a large deposit of copper ore, Sir Robert Williams stated at the annual meeting of Tanganyika Concessions, on July 24. Estimates place the ore already outlined at 330,000 tons, averaging 4.5 per cent copper. Sir Robert also gave an estimate of the ore reserves in the Kansanshi mine, under development by Rhodesia-Katanga, in which Tanganyika holds a controlling interest. They are put at 8,000,000 tons, averaging 4.15 per cent copper, compared with 1,370,000 tons, with an average grade of about 5 per cent copper, on June 30, 1929.

. . . . The Tanganyika dividend for 1929 is unchanged, but payment of the 1930 interim distribution will be deferred. Sir Robert also stated that the ultimate production of Union Minière, in which Tanganyika has a large interest, has been little more than half reached. Inasmuch as last year Union produced more than 150,000 short tons of copper, an eventual output of 300,000 tons by the Belgian Congo company is evidently contemplated. Although, as stated by Jean Jadot, president of Union Minière, at the meeting of the latter company, production costs afford a good margin of profit even with the present low price of copper, Sir Robert stated that a still further reduction in costs could be made by running at capacity on the higher grade ore only.

. . . . Two good diamond-drill holes have been completed at properties in the Rhodesian Selection Trust group during the last two weeks. Chambishi, which is completely held by Rhodesian Selection, has cut 20 ft. of ore, averaging 5.28 per cent sulphide copper, at a depth of 1,208 ft. in its hole No. 32. This hole is about 500 ft. southwest of No. 20, which cut 18.5 ft. averaging 5.77 per cent copper at a depth of 687 ft. Together with Nos. 33, 34, and 35, which have already been completed, this hole outlines an area about 2,500 ft. wide and 3,500 ft. long in which ore of an average grade of about 4 per cent copper has been proved. No plans for production from Chambishi have yet been made, but results from the deeper holes have been so encouraging that eventual large production is evidently assured.

. . . . At Roan Antelope, hole No. 21B has cut ore at a depth of 2,562.6 ft., the greatest depth yet reached on the property. It indicates a true width of 22.7 ft., averaging 3.85 per cent total copper, of which only 0.12 per cent is oxide. Core recovery was 57 per cent. The hole is about 500 ft. northeast of No. 42, which cut ore at a depth of 1,679 ft. Its importance lies largely in that it proves a continuation of good-grade ore over a substantial width to the bottom of the Roan Antelope syncline.

. . . . Rhodesian Broken Hill Development has issued its report for 1929. Zinc production was 12,121 long tons, compared with 9,579 long tons in 1928. Lead production was 1,635 long tons, compared with 4,675 tons in 1928. Total profit was £6,530. Extraction of the zinc content of the ore was 72.17 per cent, compared with 70.86 per cent. R. H. Stevens, the general manager and metallurgist, expects an 85 per cent recovery eventually. For the first half of 1930, output was 9,489 long tons of zinc. Completion of the vanadium oxide plant is expected by next January. A market has already been found for part of this production.

■

Statistical Position of Lead Sound, Horne Declares

London, Aug. 2.—At the annual meeting of the Zinc Corporation, which operates a large lead-zinc mine at Broken Hill, New South Wales, Sir Robert Horne, the chairman of the board of directors of the company, said that he believed that the present statistical position of the lead market was sounder than for some time in the past. Sir Robert disagrees with attempts at the fixing or manipulation of commodity prices. He stated that he prefers to regulate supplies to consumption requirements. The open market must be the final arbiter in deciding the price, he declared.

. . . . The Zinc Corporation is not relying on higher prices but on greater efficiency and definite economies in operations for increased profits, Sir Robert stated. The company is now trying to cut cost of production by 5s. per ton of ore handled. Profits in 1929 were £246,050. The labor agreement now in force in the Broken Hill district will terminate on Nov. 1, owing to the low price of metals.

. . . . Restriction of tin production is now proceeding, but the rhetorical discussion of what should be done for the industry has not abated. One authority claims that the present policy of making public the total cost of production is a wrong one; that the public does not know how to interpret the figures, and that a false impression is created. Anglo-Oriental Mining, the parent company in the Howeson group, has placed 1,000,000 ordinary shares, par value 5s., with a powerful company. A report in the *Financial Times* states that the company is Consolidated Gold Fields.

. . . . Australian gold mines are still asking for a bonus on production. They ask for a bonus of £1 for each ounce of metal produced, or about 25 per cent. Their ground for asking this bonus is of course the familiar one that cost of production has risen enormously, whereas the selling price is fixed.

. . . . Chilean interests and synthetic nitrogen producers are conferring in Paris on the division of the world market between Chilean nitrate and the artificial production. Important results are expected. Cosach (Compañia Salitrera Chilena, the new name of the company formed to take over the entire Chilean industry) will issue £17,000,000 worth of bonds in the New York market in October to finance plant construction.

■

New Zinc Cartel Includes Most Producers Outside Europe

Berlin, July 29.—The new zinc cartel, which was successfully organized last week, is truly international in character and includes all the important producers of electrolytic zinc, with the exception of those in the United States and Rhodesian Broken Hill, as well as the retort-zinc smelters. American Smelting & Refining, Consolidated Mining & Smelting, and Electrolytic Zinc, which operate the only producing zinc plants in Canada, Mexico, and Australia, are included in the agreement.

. . . . One of the most important provisions of the new cartel is that, if at any time exports of metallic zinc from the United States should exceed 1,000 metric tons monthly, the cartel members are free to act as they will. This clause has been inserted because of the peculiar status of the United States in that it is at present practically self-contained, neither exporting nor importing appreciable quantities of the metal. European producers fear, however, that because of the advantageous zinc tariff, which gives American producers a higher price in their own country, the American producers may at some future date dump their surplus on the European market rather than endanger the higher price in their own market.

. . . . The price policy of the new zinc cartel will differ widely from that of Copper Exporters. That is, no attempt will be made to fix prices at any one level, but rather the price will be adjusted to general conditions. In this way, the cartel hopes to avoid encouraging large-scale production from new properties by maintaining an artificial scale of prices.

. . . . Figures for German imports and exports of metal are now available for the first six months of the year. The figures in the parentheses are for the corresponding period of 1929. Imports of crude aluminum were 3,399 metric tons (3,066) and exports of 99 per cent metal were 2,011 (1,573). No aluminum exports to the United States were reported in the first six months. Imports of lead were 45,531 metric tons (76,266); of electrolytic zinc, 7,551 (19,004); of retort zinc, 43,486 (55,751); nickel, 1,447 (2,578); copper, 71,815 (108,893); and silver, 575 kg. (1,469). Minor metals also showed a heavy drop.

. . . . Exports of metals in semi-manufactured forms totaled 64,660 tons, valued at 99,000,000 marks, compared with 45,520 tons, valued at 83,000,000 marks, in 1929. These exports included copper, tin, lead, zinc, nickel, and aluminum.

MARKET AND FINANCIAL NEWS

Low Prices Not Affecting Zinc Production

Recent low prices for zinc—the June average was 4.441c. in St. Louis and £16.422 in London—have done little or nothing to curtail the world's rate of zinc production, according to data compiled by the American Bureau of Metal Statistics. The important production of Belgium, Holland, and Poland continues to be unreported, these countries last year accounting for about 26 per cent of the world output. Details follow:

	Tons of 2,000 Lb. May	June
United States	44,578	43,473
Germany	10,060	9,668
Canada	9,204	9,204
France	9,223	8,154
Australia	5,312	5,107
Great Britain	4,934	4,691
Mexico	2,629	2,669
Rhodesia	1,831	1,828
Italy	1,516	1,552
Spain	973	957
Elsewhere	8,100	8,000
Total	98,360	95,303
Daily rate	3,173	3,177

■

Union Minière Profits Up

Net profits of Union Minière du Haut-Katanga, copper producer of the Belgian Congo, were 276,000,000 Belgian francs in 1929, compared with 254,000,000 francs in 1928. Gross profits, before depreciation, interest, or addition to reserves, were 476,000,000 francs, compared with 396,000,000 francs. Copper production was 137,000 metric tons, compared with 112,500 metric tons in 1928. Dividends declared amounted to 206 francs on the 500-franc preference shares and 249 francs on the 100-franc ordinary shares. The company has outstanding bonds totaling 400,000,000 francs.

■

Vieille-Montagne Earnings

Vieille-Montagne, largest European zinc producer, reports net profits of 44,312,351 francs in 1929, compared with 59,693,840 francs in 1928. Operating profit was 88,778,045 francs, compared with 96,523,000 francs in 1928. In addition to the depressed zinc market, an increase of nearly 5,000,000 francs in interest on loans was responsible for the decreased profit. The company's production of zinc was 112,000 metric tons, compared with 110,888 metric tons in 1928. As a result of financing, potential producing capacity is being raised to 150,000 metric tons annually, but this will not be used until market conditions are more favorable. Dividends paid in 1929 totaled 30,375,000 francs, compared with 40,500,000 francs paid in 1928.

■

Stockholders Subscribe for Entire C. M. & S. Issue

Consolidated Mining & Smelting has announced that the entire new stock issue of 25,502 shares, or one share for every twenty shares outstanding, has been subscribed for by existing shareholders at $200 per share, thus reinforcing the treasury to the extent of $5,100,400. The issue was made to help absorb the cost of the new fertilizer plant—the first unit is expected to cost between $7,000,000 and $8,000,000—and other construction and development work in which the company is engaged.

The last annual balance sheet showed current assets invested in Dominion, Provincial, municipal, and industrial bonds, and cash in banks and on hand, to the amount of $14,989,226, but the directors considered it advisable not to imperil the strong treasury position; hence the new issue. An interesting feature in connection with the new issue was that much of it was subscribed for when the stock exchange quotations ranged between $180 and $190. The Canadian Pacific Railway Company and associated interests hold a controlling interest in Consolidated's stock.

■

Ontario Gold Production

Production of gold from Ontario increased slightly in June. Kirkland Lake, for the second time this year, exceeded Porcupine in the value of its contribution. Figures, compared with 1929, follow:

	1930	1929
Porcupine, June	$1,347,189	$1,529,598
Porcupine, May	1,545,110	1,687,477
Kirkland Lake, June	1,552,921	1,358,690
Kirkland Lake, May	1,349,969	1,157,028
Howey, June	52,000	.....
Howey, May	50,827	.....
Total, June	$2,952,110	$2,888,288
Total, May	2,933,906	2,853,704

■

MAGMA COPPER, operating a property at Superior, Ariz., reports net earnings of $222,737 in the second quarter of 1930, compared with $813,738 in the second quarter of 1929. Production was 8,028,977 lb. of copper at a cost of 9.51c. a pound.

Estimate 1930 Tin Curtailment at 17,100 Long Tons

The Tin Producers' Association in London in an official announcement computes aggregate curtailment of tin production during the remainder of this year at 17,100 long tons of fine metal. This figure is reached in the following way:

The 94 British companies which have accepted the council's recommendation for a two months' production holiday have an annual production of 43,000 long tons, based on actual output during the last half of 1929. As some of their plants were not then in full operation. curtailment of output affected by two months' shutdown and subsequent 20 per cent curtailment is estimated for the current half-year at over 9,200 long tons of metallic tin. Some of the companies are actually closing down for three months or longer, a fact disregarded in the calculation.

Sixteen other companies with combined output during 1929 of 7,700 long tons of metallic tin are now producing approximately 20 per cent less than in 1929, making their curtailment for the remainder of 1930 approximately 900 long tons.

The principal Bolivian and Dutch producers have agreed to a 25 per cent curtailment from June 1. Based on 1929 shipments of 43,033 long tons of metallic tin from Bolivia and 12,982 long tons from Billiton, curtailment for the remainder of this year should be not less than 7,000 long tons from these two fields.

If negotiations now under way with Chinese producers and other nonmembers are successful, the aggregate curtailment of 17,100 long tons may be substantially enlarged.

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BUTTE COPPER & ZINC, operating a manganese property in Montana, reports net profit of $37,196 in the second quarter of 1930, compared with a net loss of $18,953 in the preceding quarter and a net profit of $53,364 in the corresponding quarter of 1929. Total sales of ore for the quarter were $48,985, compared with $63,669 in the corresponding period of 1929.

INTERNATIONAL NICKEL stockholders, at a meeting in Toronto on July 25, ratified the new issue of stock, which will be offered to stockholders at $20 a share in the quantity of six shares of new stock for every 100 shares now held.

World Lead Output Declining

Both the total tonnage of refined lead produced in the world and the daily rate declined in June, compared with May, according to data just released by the American Bureau of Metal Statistics. Comparative figures, in tons of 2,000 lb., follow:

	May	June
United States	52,818	50,721
Mexico	26,139	21,110
Europe	17,900	18,100
Australia	15,055	14,943
Canada	13,284	12,789
Germany	9,790	10,938
Spain and Tunis	8,567	9,354
Burma	7,414	7,444
Italy	2,537	2,276
Peru	2,566	1,666
Elsewhere	1,200	1,200
Totals	157,270	150,541
Daily rate	5,073	5,018

■

Financial Notes

GRANBY CONSOLIDATED, operating copper properties in British Columbia, reports profits of $418,099 for the second quarter of 1930, comparing with $688,836 in the previous quarter, and $1,164,813 in the corresponding quarter of 1930. Cost of producing copper was 9.95c. before depreciation, depletion, and taxes, and production was 12,317,156 lb.

DOME MINES, operating a gold mine in northern Ontario, reports a net profit of $48,924 in the first half of 1930. Production, recovered entirely from ore in process at the date the mill burned, was $344,908, and an operating loss of $117,852 was recorded.

HOLLINGER CONSOLIDATED milled in the first quarter of 1930 401,431 tons of gold ore and, in the first half, 802,112 tons, at its property in northern Ontario. Average recovery in the first quarter was $6.42 a ton, and in the first half, $6.55.

CONSOLIDATED LEAD & ZINC, operating mines in the Tri-State district, reports net profits of $74,992 before depreciation, depletion, and taxes, in the first six months of 1930. In the corresponding period of 1929, profits were $193,663. Operations have now been suspended at all the company's mines except No. 8 because of low metal prices.

NIPISSING MINING, operating at Cobalt, Ont., reports production valued at $230,546 in the second quarter of 1930, compared with $263,965 in the first quarter of the year. The drop is accounted for entirely by the decline in the price of silver, as actual production is unchanged.

WAIHI GOLD MINING, operating in New Zealand, treated 213,879 tons of ore during 1929, at a net profit of £85,869, compared with £85,560 for the previous year. Dividends amounting to 40 per cent were paid, and a credit balance of £5,257 was carried forward. In 1929, 186,883 tons of new ore was developed.

BROKEN HILL PROPRIETARY BLOCK 14, operating a lead-zinc-silver mine in New South Wales, made a net loss of £7,478 in the six months ended March 31, 1930, compared with a net loss of £6,922 in the previous half year. A total of 22,741 tons of ore was produced during that period.

SOCIÉTÉ LE NICKEL, operating in New Caledonia, made a profit of 3,224,901 francs in 1929, compared with 2,912,641 francs in 1928. After deduction of sundry charges, the transfer to profit-and-loss was 3,167,033 francs. Dividends paid totaled 3,000,000 francs.

TEXAS GULF SULPHUR, operating in Texas, reports a net profit of $3,648,346 in the second quarter of 1930. After paying a dividend of $2,540,000, the company's total surplus and reserve for depletion was $23,760,607 on June 30.

SOCIÉTÉ MINE ARMORIQUE is increasing its capital from 6,000,000 to 10,000,000 francs to permit completing construction of a road, 100 km. long, to its property near Tulé, on the Red River, in the Province of Yenby, French Indo-China. The property carries high-grade silver-lead ore.

U. S. Phosphate Output in 1929 Close to 1920 Record

Phosphate rock sold or used by producers in 1929 exceeded all previous records except for 1920, and amounted to 3,761,164 long tons, valued at $13,153,259, according to the U. S. Bureau of Mines. The quantity and value, by states, of the various kinds of phosphate rock sold or used by producers in 1929 were as follows:

	Long Tons	Value
Florida:		
Hard rock	72,733	$267,218
Land pebble	3,015,874	9,633,856
	3,088,607	$9,901,074
Idaho:		
Western rock	35,899	141,931
Montana:		
Western rock	40	400
Tennessee:		
Brown and blue rock	633,939	3,097,104
Wyoming:		
Western rock	2,679	12,750
	3,761,164	$13,153,259

Although the total sales of phosphate rock by producers in 1929 increased 7 per cent in quantity and 6 per cent in value, compared with 1928, there was continued decrease in production of Florida hard rock and continued decline in the domestic market for phosphate rock in the Western states. The average selling value of all varieties was $3.50, f.o.b. mines, compared with $3.55 in 1928.

Imports in 1929, about 2 per cent less than in 1928, amounted to 44,899 long tons, valued at $469,171. Exports were the largest of any year except 1903, being 1,142,746 long tons, valued at $5,386,919, according to the official records. Producers in Florida alone reported shipments during 1929 from the mines for export. These export shipments amounted to 1,110,325 long tons, consisting of 94 per cent land pebble and 6 per cent hard rock, which together constituted 36 per cent of the total sales in Florida in 1929, and showed an increase of 25 per cent compared with 1928. Output of land pebble in Florida increased 8 per cent in 1929 over 1928, and this increase was apparently all accounted for in the exports, as shipments of land pebble to domestic markets were less than in 1928. Total sales to domestic consumers, which comprised 64 per cent of the Florida sales and all the sales of the other producing states, Idaho, Montana, Tennessee, and Wyoming, indicated a small increase in the quantity of phosphate rock consumed in the United States in 1929 compared with 1928.

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GEORGIA MANGANESE & IRON, in which Brunswick Terminal & Railway Securities holds $1,500,000 of first mortgage bonds, has been placed in receivership, incidental to reorganization. Brunswick Terminal also has a 40 per cent interest in American Minerals Corporation, a holding company that has all the capital stock of Georgia Manganese & Iron.

Complete Market News and Prices

THE semi-monthly magazine you are now reading carries only a condensed review of important market news and price movements. For buyers and sellers of ores, metals, minerals, and scrap who require reliable information as soon as it is available, we now provide *Metal and Mineral Markets*, which goes to press at the close of the metal-market week each Wednesday. It is printed at high speed and is in the mails that evening. In compact form, ready for insertion in a ring binder, it is ideal for desk and reference use. It carries the standard *E.&M.J.* quotations used in contracts the world over, recognized as authoritative and dependable. *Metal and Mineral Markets* is priced to subscribers in the United States and its possessions at $2 per annum; to countries in the Americas but outside the United States, $5; elsewhere, $10 yearly: 52 issues. Address *M.& M.M.*, 36th St. and 10th Ave., N.Y.City.

Active Demand for Copper, Lead, Zinc; Lead Prices Advanced

New York, Aug. 6, 1930.—The low prices that have been quoted for the non-ferrous metals recently have at last attracted considerable buying, especially for copper, lead, and zinc, and producers are encouraged. The *E.&M.J.* Weighted Index of Non-Ferrous Metal Prices declined to a new low of 74.58 in July, compared with 78.57 in June, but as the current prices of lead, zinc, and tin are higher than the July average, and copper is stable at but little less, there seems to be a fair prospect that the Index may at last turn upward, and that conditions as to both price and volume of production may improve during the fall and winter.

On July 17, copper dropped to an even 11c., delivered Connecticut, and the metal has held at that price ever since. Practically all selling agencies are at that level and are sharing in the business, but demand has been so active that the custom smelters have sold all they care to, and there seems no immediate likelihood of lower prices through forced sales in that direction. The last two weeks in July witnessed an extremely heavy business in both the domestic and foreign market; so far in August, the demand has lightened considerably, but there are still many unsatisfied bids for November and December shipment at 11c., and some small buyers who are not regular customers of the large producers have not been able to obtain copper for less than 11¼c. The demand for copper has been largely speculative; that is, manufacturers are buying it because it is cheap rather than because they actually need it for their current operations or to cover business that they have placed. They would now not be averse to seeing the price gradually advance, and they believe that this would stimulate buying by the ultimate consumer. Only the public utilities have so far been attracted much by the low prices. In the Middle West the usual premiums of ¼c. over Connecticut prices have generally been obtainable. Copper Exporters, Inc., reduced the foreign quotation to 11.30c., c.i.f., on July 22.

Lead business has been excellent since about the tenth of July. The last week in that month saw the biggest volume of sales in some years, thanks to one order for 5,000 tons. Demand promises to continue good, and the usual advance in prices which almost always comes in August (though last year was an exception) has already begun. American Smelting & Refining advanced its New York contract price from 5.25 to 5.35c. on Friday, Aug. 1, and again to 5.50c. on Monday, Aug. 4. St. Louis producers advanced to 5.25c. on the first, but only came up to 5.35c. on Monday, thus re-establishing the former differential of 15 points between the New York and St. Louis markets. Cable manufacturers have been prominent among the buyers; the battery demand has been light but is expected to improve soon. Coincident with the higher lead prices, galena concentrates in the Joplin market sold at $65 on Aug. 1, after resting at $60 since the end of June.

Though zinc stocks increased to 117,381 tons in July, the were concentrated in the hands of four producers who were in no mood to let them go except at rapidly advancing prices during the latter part of July. Some consumers actually needed the metal and others were tempted to buy by the advance, especially for forward shipment, for which sellers tried to get a little premium. Business therefore was active in the last two weeks of July, until the price got as high as 4⅞c., whereupon the buyers decided to go on strike, and in the last week the price has fallen about as rapidly as it rose, settling back to 4.45c. today. Blende in Joplin was sympathetically affected, going up to $30 on July 19, basis 60 per cent zinc concentrate of premium and Prime Western grade, and to $33.50 on July 26, subsequently reacting to $32 last week.

Tin has worked its way slightly above 30c. again for prompt Straits, and seems more stable, thanks to a slight decrease in visible supplies at the end of July, for the first time in months, and to what seems to be a real curtailment now being effected in the British-controlled areas in the Far East.

Silver continues to be stable around 34c., with a fair demand from India on recessions. Antimony has taken a sudden spurt upward owing to the civil war in the antimony-producing and -shipping districts of China, whence three-quarters of the world's antimony comes.

Average Metal Prices for July, 1930

COPPER:	
Electrolytic, refinery	11.023
London Standard Spot	48.277
London Electrolytic Spot	52.522
LEAD:	
New York	5.250
St. Louis	5.149
London Spot	18.160
London Forward	18.063
SILVER:	
New York	34.346
London	15.928
Sterling Exchange	486.300
ZINC:	
St. Louis	4.350
London Spot	16.171
London Forward	16.777
TIN:	
Straits	29.822
London Standard Spot	134.511
QUICKSILVER	117.462
ANTIMONY	6.976
PLATINUM:	
Refined	43.692
ALUMINUM 99 Per Cent Plus	23.300

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus: 23.30c., delivered; 98@99 per cent, 22.90c. Demand quiet.

ANTIMONY—Per lb., duty paid: Chinese, spot, 8@8⅛c.; futures, 7¾@8c. Price advanced to 7⅞c. on July 31, and has continued to strengthen since then on account of closely held supplies in the United States and the absence of business in China due to revolutionary activities at Changsha. A real shortage may develop. Cookson's "C" grade spot, nominally 12¾c. C.M.C. 99.9 per cent pure, spot, 10¾c.

BISMUTH—Per lb., $1 in ton lots.

CADMIUM—Per lb., 70c. in ton lots. London, 3s. 5d.

IRIDIUM—Per oz., $240@265.

MAGNESIUM—Per lb., 65c.@$1, 99½ per cent ingots.

NICKEL—Per lb., spot ingot and electrolytic (99.9 per cent), 35c.; shot, 36c. Contracts less.

OSMIUM—Per oz., $65@$70. London, £15¼.

PALLADIUM—Per oz., $23@$24. London, £4¼.

PLATINUM.—Per oz., official price quoted by the leading interest on small orders for the refined metal, $43 per oz. Outside market among dealers and refiners is nominally quoted at several dollars less, for cash. July average price of crude, $38.192. London £8¼.

QUICKSILVER—Per 76-lb. flask, $116.

Prices of Chromium, Cobalt, Manganese, Radium, Rhodium, Ruthenium, Selenium, Silicon, Tantalum, Tellurium, and Tungsten are unchanged from the issue of July 10.

Non-Metallic Minerals

LEPIDOLITE—Per ton, $50@$60 for ordinary grades.

MICA—F.o.b. *New Mexico* mines, waste and scrap, $15 per ton; punch, 6c. per lb., sheet 18c.@$4.50 per lb., according to size. Fair demand for scrap and good market for sheet and punch.

SPODUMENE—Per ton, $50@$60, according to lithium content.

Amblygonite, Asbestos, Barium Carbonate, Barytes, Bauxite, Borax, Celestite, China Clay, Emery, Feldspar, Fluorspar, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Limestone, Magnesite, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystals, Silica, Sulphur,

Daily Prices of Metals

July August	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
17	10.775	29.875	5.25	5.15	4.20@4.30
18	10.775	29.625	5.25	5.15	4.25@4.30
19	10.775	29.625	5.25	5.15	4.275@4.30
21	10.775	30.000	5.25	5.15	4.35
22	10.775	29.625	5.25	5.15	4.425
23	10.775	29.75	5.25	5.15	4.40
Av'ge	10.775	29.750	5.250	5.150	4.331
24	10.775	29.75	5.25	5.15	4.50@4.70
25	10.775	29.875	5.25	5.15	4.60@4.75
26	10.775	29.875	5.25	5.15	4.60@4.75
28	10.775	30.125	5.25	5.15	4.75@4.875
29	10.775	29.875	5.25	5.15	4.75
30	10.775	29.875	5.25	5.15	4.75
Av'ge	10.775	29.896	5.250	5.150	4.710
31	10.775	30.00	5.25	5.15	4.70
1	10.775	30.15	5.35	5.25@5.275	4.60
2	10.775	30.15	5.35	5.275	4.55
4	10.775	30.20	5.50	5.35	4.50@4.525
5	10.775	30.25	5.50	5.35	4.475
6	10.775	30.10	5.50	5.35	4.45
Av'ge	10.775	30.142	5.408	5.290	4.548

Average prices for calendar week ended July 19, 1930, are: Copper 10.942c.; Straits Tin, 29.688c.; New York lead, 5.250c.; St. Louis lead, 5.146c.; Zinc, 4.231c.; Silver, 34.229c.

Average prices for calendar week ended July 26, 1930, are: Copper 10.775c.; Straits tin, 29.813c.; New York lead, 5.250c.; St. Louis lead 5.150c.; Zinc, 4.521c.; Silver, 34.792c.

Average prices for calendar week ended Aug. 2, 1930, are: Copper, 10.775c.; Straits tin, 30.029c.; New York lead, 5.283c.; St. Louis lead, 5.190c.; Zinc, 4.694c.; Silver, 34.542c.

London

July August	Copper Standard		Electrolytic	Tin		Lead		Zinc	
	Spot	3 M		Spot	3M	Spot	3M	Spot	3M
17	47¾	47⅝	52	135½	137⅛	18¼	18⅛	16½	17¼
18	47¼	47⅛	52	134¼	135¾	18 3/16	18⅛	16 7/16	17
21	47 5/16	47⅛	51	135½	137¼	18 3/16	18¼	16¼	16 13/16
22	47 7/16	47¼	50½	135⅛	137	18⅛	18 1/16	16 11/16	17⅛
23	47 7/16	47 5/16	50½	134½	136¼	18 3/16	18¼	16 13/16	17 5/16
24	48¾	48½	50½	134½	136½	18¼	18 3/16	16 13/16	17 5/16
25	49⅝	49 9/16	51½	134 7/8	136⅝	18¼	18 3/16	16 13/16	17 5/16
28	48 11/16	48½	51½	135 7/8	137⅝	18¼	18 3/16	16 11/16	17¼
29	48½	48⅜	51½	134¾	136⅜	18 5/16	18¼	16½	17⅛
30	48⅜	48 3/16	51¼	134⅜	135⅞	18¼	18 3/16	16¼	16¾
31	48 3/16	48 3/16	51¾	134⅝	136⅜	18¼	18 1/16	16	16 9/16
1	48½	48½	51	135⅝	137¼	18 3/16	18 3/16	16 1/16	16 11/16
4				Holiday					
5	48¾	48¾	51	136⅞	138⅝	18¼	18¼	16	16⅝
6	48⅝	48 9/16	51	135½	137½	18⅜	18 5/16	15 15/16	16½

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Silver, Gold, and Sterling Exchange

July	Sterling Exchange "Checks"	Silver New York	Silver London	Gold London	July Aug.	Sterling Exchange "Checks"	Silver New York	Silver London	Gold London
17	$4.86¼	34¼	16	85s 1½d	28	$4.86⅝	34 7/16	16¼	85s0¾ d
18	4.86⅛	34⅛	15 7/8	85s 1½d	29	4.86 13/16	34⅜	16 1/16	85s0⅝ d
19	4.86 3/16	34¼	15 7/8	.....	30	4.86 11/16	34½	16	85s0½ d
21	4.86¼	34½	15 15/16	85s 1½d	31	4.86¾	34⅝	16	85s0⅜ d
22	4.86½	34⅝	16	85s 1 d	1	4.86 15/16	34⅝	16	84s11 7/8d
23	4.86⅜	34⅝	16 1/16	85s 1 d	2	4.87	34¼	15 7/8	.....
24	4.86 7/16	34⅝	16	85s 1 d	4	4.86 15/16	34½	Holiday	Holiday
25	4.86⅜	35	16 3/16	85s 1 d	5	4.87	34½	15 15/16	84s11¾d
26	4.86 7/16	35⅛	16 7/16	.....	6	4.87	34½	15 15/16	84s11¾d

Average for week ended July 23: Silver, 34.396c.; Sterling Exchange, $4.86281.
Average for week ended July 30: Silver, 34.833c.; Sterling Exchange, $4.86563
Average for week ended Aug. 6: Silver, 34.417c.; Sterling Exchange, $4.86938

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command nine-thirty-seconds cent premium.

Talc, and Tripoli are unchanged from prices in the July 10 issue.

Metallic Ores

TANTALUM ORE—Per lb., f.o.b. New Mexican mines, crude ore with minimum 40 per cent Ta_2O_5, 40c. Good demand.

Antimony, Beryllium, Chrome, Iron, Manganese, Molybdenum, Tin, Titanium, Tungsten, Vanadium, and Zircon Ores are unchanged from the quotations in the July 10 issue.

Alloys

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.10@$1.15.

NICKEL SILVER—Per lb., sheets, 10 per cent, 25¼@25¾c.; 18 per cent, 28½@29c. Wire and rods, 10 per cent, 28¾c.; 15 per cent, 32½c.; 18 per cent, 36c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 32c.; wire, 5 per cent, 32½c.; 10 per cent, 38c.

SPIEGELEISEN—Per gross ton, 18@21 per cent Mn, $33.

Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrocarbontitanium, Ferrovanadium, Silicon Zirconium, and Zirconium Ferrosilicon are unchanged from prices quoted in July 10 issue.

Rolled Metals

COPPER—Per lb., sheets, hot-rolled, 20¾c.; rolls and strips, 19¾c.; wire, f.o.b. mill, 12¾c.

ZINC—Per lb., in 500-lb. boxes, f.o.b. mill, 9½c. for sheets; 9c. for ribbon; 7 per cent discount on orders for 18 tons or more.

Lead, Monel, and Nickel Sheets unchanged from quotations in July 10 issue.

Metallic Compounds

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, for either large or small crystals, 4¼c.

SODIUM NITRATE—Per 100 lb., crude, natural, in bags ex vessel, Atlantic ports, price reduced to $1.99 for shipment to end of September.

Arsenious Oxide, Calcium Molybdate, Cobalt Oxide, Sodium Sulphate, and Zinc Oxide are unchanged from the quotations in the July 10 issue.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $18.50; basic and No. 2 foundry, $18.

STEEL—Per gross ton, Pittsburgh, base prices, billets and slabs, $31; plates and structural shapes, per 100 lb., $1.65 @$1.70; soft steel bars, $1.65@$1.75.

COKE — Unchanged from prices in July 10 issue.

Refractories

Chrome, Fireclay, Magnesite, Silica, and Zirkite refractories are unchanged from quotations in the issue of July 10.

METAL STATISTICS

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1929	1930	1929	1930	1929	1930
January	57.019	45.000	26.257	20.896	484.577	486.447
February	56.210	43.193	25.904	20.008	484.787	485.784
March	56 346	41.654	26.000	19.298	484.776	485.933
April	55.668	42.428	25.738	19.554	484.808	486.019
May	54.125	40.736	25.084	18.850	484.599	485.724
June	52.415	34.595	24.258	16.049	484.330	485.625
July	52.510	34.346	24.289	15.928	484.560	486.300
August	52.579	.....	24.288	.....	484.368	.....
September	51.042	.....	23.708	.....	484.253	.....
October	49.913	.....	23.042	.....	486.392	.....
November	49.615	.....	22 690	.....	487.104	.....
December	48.475	.....	22.258	.....	487.523	.....
Year	52.993	.....	24.460	.....	485.173	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery		London Spot			
	Electrolytic		Standard		Electrolytic	
	1929	1930	1929	1930	1929	1930
January	16.603	17.775	75.551	71.469	78.602	83.250
February	17.727	17.775	78.228	71.419	83.538	83.500
March	21.257	17.775	89.153	69.202	98.356	83.405
April	19.500	15 621	81.036	62.075	89.405	74.338
May	17.775	12.756	75.026	53.159	83.727	59.545
June	17.775	12.049	74.338	50.003	84.013	56.750
July	17.775	11.023	72.152	48.277	84.043	52.522
August	17.775	.....	73.783	.....	84.250	.....
September	17.775	.....	75.286	.....	84.363	.....
October	17.775	.....	72.815	.....	83.978	.....
November	17.775	.....	69.324	.....	82.202	.....
December	17.775	.....	68.303	.....	82.569	.....
Year	18.107	.....	75.416	.....	84.921	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1929	1930	1929	1930	1929 Spot	1929 3 Mos.	1930 Spot	1930 3 Mos.
January	6.650	6.250	6.498	6.100	22.111	22.344	21.545	21.571
February	6.853	6.236	6.739	6 086	23.128	23.156	21.188	21.097
March	7.450	5.662	7.348	5.542	25.409	25.591	18.807	18.940
April	7.187	5.537	7.025	5.428	24.783	24.408	18.319	18.363
May	7.000	5.523	6.761	5.408	23.949	23.750	17.795	17.861
June	7.000	5.410	6.790	5.310	23.694	23.603	17.941	17.994
July	6.804	5.250	6.607	5.149	22.810	22.880	18.160	18.063
August	6.750	.....	6.553	.....	23.185	23.259	.....	.....
September	6 890	.....	6.689	.....	23.557	23.589	.....	.....
October	6.873	.....	6.674	.....	23.226	23.253	.....	.....
November	6.285	.....	6.135	.....	21.622	21.643	.....	.....
December	6.250	.....	6.100	.....	21.472	21.484	.....	.....
Year	6.833	.....	6.660	.....	23.246	23.247	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1929	1930	1929	1930
	Straits		Spot	
January	49.139	38.851	222.727	175.466
February	49.347	38.676	223.138	173.750
March	48.870	36.798	220.781	164.851
April	45.858	36.077	206.887	162.638
May	43.904	32.108	197.545	144.818
June	44.240	30.336	200.206	136.300
July	46.281	29.822	209.473	134.511
August	46.619	.....	209.815	.....
September	45.359	.....	204.863	.....
October	42.290	.....	190.783	.....
November	40.208	.....	180.565	.....
December	39.745	.....	179.419	.....
Year	45.155	.....	203.850	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1929	1930	1929 Spot	1929 3 Mos.	1930 Spot	1930 3 Mos.
January	6.350	5.229	26.196	26.233	19.634	20.241
February	6.350	5.180	26.247	26.347	19.209	19.778
March	6.463	4.934	27.050	27.294	18.304	18.810
April	6.658	4.843	26.759	26.613	17.819	18.378
May	6.618	4.641	26.727	26.619	16.639	17.324
June	6 686	4.441	26.216	25.984	16.422	17.038
July	6.766	4.350	25.332	25.418	16.171	16.777
August	6 800	.....	24.896	25.164	.....	.....
September	6 799	.....	24.208	24.688	.....	.....
October	6.740	.....	22.927	23.329	.....	.....
November	6 242	.....	20.851	21.351	.....	.....
December	5.666	.....	20.072	20.672	.....	.....
Year	6.512	.....	24.790	24.976	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1929	1930	1929	1930	1929	1930
January	9.558	8.606	119.481	121.192	70.000	61.923
February	9.548	8.830	119.818	120.500	70.000	59.909
March	9.531	8.236	121.904	118.808	70.000	54.769
April	9.462	7.740	122.000	114.000	70.000	46.462
May	8.957	7.454	121.154	117.269	68.615	46.000
June	8.845	7.057	120.500	118.600	68.000	46.000
July	8.543	6.976	121.654	117.462	68.000	43.692
August	8.778	.....	125.111	.....	68.000	.....
September	8.709	.....	124.542	.....	66.000	.....
October	8.538	.....	124.298	.....	65.000	.....
November	8.583	.....	123.323	.....	65.000	.....
December	8.420	.....	121.950	.....	63.240	.....
Year	8.956	.....	122.145	.....	67.655	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1929	1930	1929	1930	1929	1930	1929	1930
Jan	18.00	19 00	17.50	18.50	17.50	18 50	24.300	24.300
Feb	18.00	19.00	17.50	18.50	17.50	18.50	24.300	24.300
March	18.19	19.00	17.62	18 50	17 69	18 50	24.300	24.300
April	18.50	19 00	18.00	18.50	18.00	18 50	24.300	24.300
May	18.81	19.00	18.31	18.50	18.31	18.50	24.300	24.300
June	19.00	19 00	18.50	18 50	18.50	18 50	24.300	24.140
July	19.00	18.62	18.50	18.12	18.50	18 12	24.300	23.300
Aug	19.00	. ..	18.50	. ..	18.50	... .	24.300	....
Sept	19.00	. ..	18.50	.....	18.50	... .	24.300	.....
Oct	19.00	.....	18 50	.....	18.50	... .	24.300	....
Nov	19.00	. ..	18.50	. ..	18.50	... .	24.300	....
Dec	19.00	.....	18 50	.....	18.50	.....	24.300	....
Year	18.71	.. ..	18.20	.....	18.21	....	24.300	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76.

Monthly Crude Copper Output in Short Tons

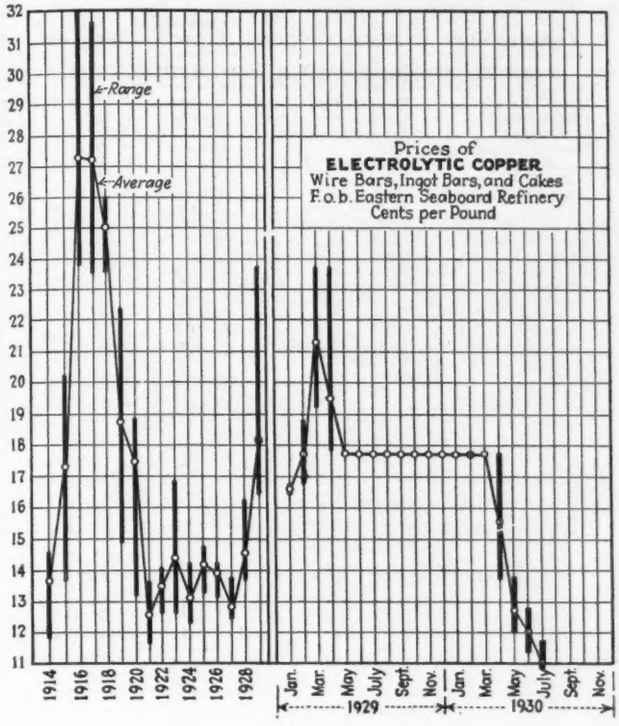
	1929 Total	1930 Feb.	March	April	May	June
Domestic						
Alaska shipments	21,947	1,298	2,109	1,416	1,052	1,250
Calumet & Arizona	65,246	3,665	3,550	3,752	3,799	3,939
Magma	19,118	1,068	1,178	1,309	1,556	1,150
Miami	29,567	2,564	3,081	2,762	2,984	2,893
Nevada Cons	133,140	.....	(d) 19,850	.....	.....	.....
Old Dominion (a)	11,172	843	885	1,045	964	845
Phelps Dodge (b)	111,026	6,037	6,048	6,034	6,049	6,037
United Verde Extens	29,669	1,869	1,681	2,047	2,007	1,790
Utah Copper	148,312	.....	.....	.....	.....	.....
Tennessee Copper	7,870	659	672	653	676	596
Foreign						
Andes Copper	83,718	3,699	8,351	4,155	.....	.....
Braden	88,155	4,618	4,729	4,610	.....	.....
Boleo, Mexico	13,196	.....	(d) 3,537	.....	.....	(d) 3,636
Bwana M'Kubwa	6,988	659	556	525	489	501
Chile	150,247	7,488	7,478	7,489	.....	.....
Furukawa, Japan	17,767	1,604	1,627	1,542	1,625	.....
Granby, Cons., Canada	30,424	1,791	1,726	1,891	2,063	2,204
Howe Sound	21,516	.....	(d) 5,876	.....	.....	(d) 5,698
Messina	(c) 7,200	554	655	576	718	729
Mt. Lyell	7,600	.....	(d) 3,035	.....	.....	.....
Sumitomo, Japan	20,180	1,207	1,576	1,404	.....	.....
Union Minière, Africa	151,006	.....	.....	.....	.....	(e) 72,800

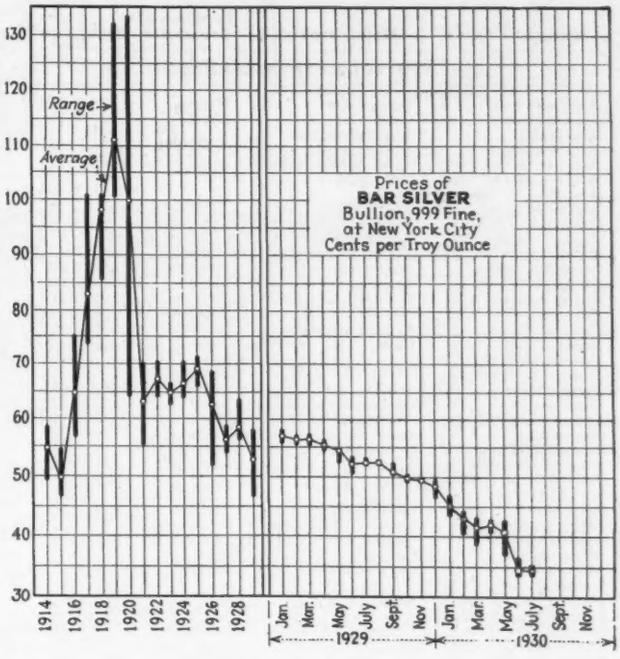
(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Estimated. (d) Three months. (e) Six months.

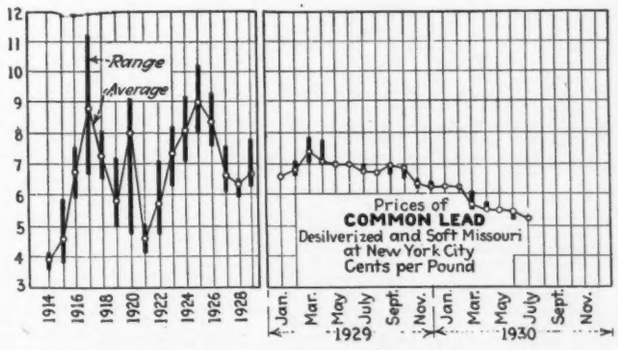
Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

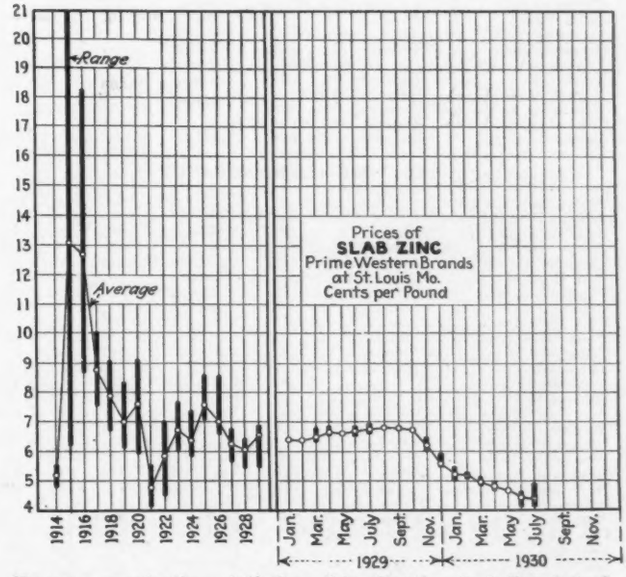
	1928		1929		1930	
	Monthly Production	Daily Rate	Monthly Production	Daily Rate	Monthly Production	Daily Rate
January	68,469	2,209	86,324	2,785	67,838	2,188
February	67,423	2,352	84,735	3,026	59,196	2,114
March	70,327	2,269	93,698	3,023	61,216	1,975
April	69,721	2,324	94,902	3,163	60,450	2,015
May	73,729	2,378	93,392	3,013	60,228	1,943
June	73,224	2,441	82,354	2,745	56,465	1,882
July	73,426	2,369	79,229	2,556	.....	.....
August	76,952	2,482	78,885	2,545	.....	.....
September	78,341	2,611	79,402	2,647	.....	.....
October	86,480	2,790	82,575	2,664	.....	.....
November	85,382	2,846	75,934	2,531	.....	.....
December	85,677	2,764	74,772	2,412	.....	.....
Total	909,051	.....	1,006,203	.....	365,403	.....
Monthly average	75,754	.....	83,850	.....	60,901	.....
Av. of daily rate	.....	2,484	.....	2,757	.....	2,019

Metal Price Curves

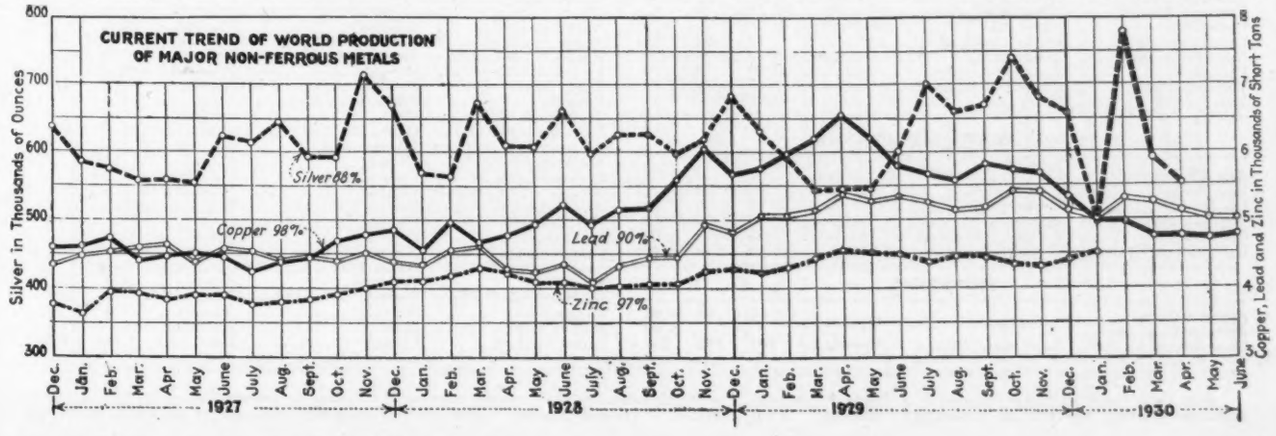








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The zinc curve has not been plotted for the past months of 1930, owing to the absence of some European production statistics; this situation is believed to be only temporary in character. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.


CURRENT TREND OF WORLD PRODUCTION
OF MAJOR NON-FERROUS METALS
Silver in Thousands of Ounces
Copper, Lead and Zinc in Thousands of Short Tons
Silver 88%
Copper 98%
Lead 90%
Zinc 97%
Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June
1927
1928
1929
1930

Mining Share Prices—Month of July, 1930

Company Name	Metals Produced	Location of Properties	High	Low	Last
NEW YORK STOCK EXCHANGE					
Ahumada Lead	Lead, silver	Mexico	0.75	0.62½	0.62½
Alaska Juneau	Gold	Alaska	5.75	5.00	5.37½
Am. Metal	Lead, silver, zinc	Various	35½	31½	31½
Am. Metal, pfd	Copper, gold	Various	108½	106	106
Am. Sm. & Ref	Lead, copper, silver	Various	70½	57½	66½
Am. Sm. & Ref., pfd.	Gold, zinc	Various	136½	134½	135½
Am. Zinc., L. & S.	Zinc, lead	Various	11½	7.50	9.87½
Am. Zinc, L. & S., pfd.	Zinc, lead	Various	65	58	62
Anaconda	Copper, zinc, silver	Various	52½	48	51
Andes Copper	Copper, silver	Chile	25	22	24½
Butte C. & Z.	Manganese, zinc	Montana	3.00	2.12½	2.62½
Butte & Superior	Zinc, silver	Montana	2.50	2.00	2.12½
Callahan Zinc-Lead	Lead, zinc	Idaho	1.12½	1.00	1.00
Cal. & Arizona	Copper, gold, silver	Arizona	58½	51	54½
Cal. & Hecla	Copper	Michigan	17½	15	15½
Cerro de Pasco	Copper, silver, lead	Peru	52½	46½	50½
Dome Mines	Gold	Ontario	8.12½	7.62½	7.62½
Federal M. & S.	Lead, zinc, silver	Idaho, Tri-State			150*
Federal M. & S., pfd.	Lead, zinc, silver	Idaho, Tri-State			96½
Freeport Texas	Sulphur	Texas	46½	38½	44
Granby Con	Copper, silver, gold	Brit. Col.	26	22½	24
Greene Cananea	Copper, silver, gold	Mexico	65½	65	65½
Homestake	Gold	So. Dakota	79½	72	78
Howe Sound	Copper, lead, zinc	Various	31	26	28
Inspiration	Copper	Arizona	17½	14½	15½
International Nickel	Nickel, copper	Ontario	25½	22½	23½
Int. Nickel, pfd.	Nickel, copper	Ontario	121½	120½	121
Kennecott	Copper, gold, silver	Various	41½	37½	39½
McIntyre-Porcupine	Gold	Ontario	18½	17½	18
Magma Copper	Copper, silver, gold	Arizona	34½	30	33
Miami Copper	Copper	Arizona	17½	15½	16½
Mother Lode	Copper, silver	Alaska	1.37½	1.12½	1.25
National Lead	Lead, zinc	Various	135½	126	130
National Lead, pfd. A	Lead, zinc	Various	141	140	141
National Lead, pfd. B	Lead, zinc	Various	119½	118	119
Nevada Con	Copper, gold, silver	Various	17½	15½	16½
Park Utah Con	Zinc, silver, lead	Utah	2.37½	1.75	2.00
Patiño M. & E.	Tin	Bolivia	19	17	18
Phelps Dodge	Copper, gold, silver	Various	36½	32	34
Rand Mines	Gold	Africa	35	35	35
St. Joseph Lead	Lead, zinc, silver	Various	41½	35	39
Seneca Copper	Copper	Michigan	2.00	1.50	2.00
Tennessee C. & C.	Copper, su. acid	Tennessee	12½	11½	11½
Texas Gulf	Sulphur	Texas	60½	51½	58½
U. S. S. R. & M.	Silver, gold, lead	Various	21½	17½	20
U. S. S. R. & M., pfd.	Zinc, copper	Various	45½	42	45½
Utah Copper	Copper, gold, silver	Utah			190*
Vanadium Corp	Vanadium, ilmenite	Various	106½	75	98½
NEW YORK CURB EXCHANGE					
Aluminum Co. of Am.	Aluminum	Various	254½	210	254½
Alum. Co. of Am., pfd.	Aluminum	Various	109	106½	109
Anglo-Chilean Con	Nitrate	Chile	38½	26½	32½
Bunker H. & S.	Lead, silver, zinc	Idaho	68	68	68
Carnegie Metals	Silver, gold	Mexico	7.37½	5.50	6.75
Con. Coppermines	Copper, gold, silver	Nevada	4.50	4.00	4.25
Copper Range	Copper	Michigan			10
Cresson Con	Gold	Colorado	0.37½	0.25	0.25
Cusi Mexicana	Lead, zinc, silver	Mexico	1.00	0.75	0.75
Evans-Wallower	Lead, zinc	Various	2.25	1.12½	2.00
Federated Metals	Trading	Various	16½	15	15
Hecla Mining	Lead, silver, zinc	Idaho	9.37½	8.87½	9.00
Hollinger Con	Gold	Ontario	5.87½	5.62½	5.75
Hudson Bay M. & S.	Copper, zinc	Manitoba	8.50	7.62½	8.25
Iron Cap Copper	Copper, silver, gold	Arizona	1.62½	1.50	1.62½
Mayflower Assoc	Holding	Various	61½	59	60
Mining Corporation	Silver, lead, zinc	Canada	1.37½	1.00	1.37½
New Jersey Zinc	Zinc, lead, silver	Various	68	65½	66
Newmont Mining	Holding, copper, gold	Various	91	84	87
N. Y. and Honduras	Silver, gold	Honduras	10½	10½	10½
Nipissing	Silver	Ontario	1.25	1.00	1.25
Noranda Mines	Copper, gold, silver	Quebec	24½	22	23½
Ohio Copper	Copper, lead, gold	Utah	0.62½	0.50	0.50
Premier Gold	Silver, gold	Brit. Col.	1.12½	0.87½	1.00
Quincy	Copper	Michigan	15½	15	15½
Shattuck Denn	Copper, gold, silver	Arizona	5.25	5.00	5.25
So. Am. Gold & Plat	Platinum, gold	Colombia	1.25	1.00	1.00
Teck-Hughes	Gold	Ontario	6.87½	6.25	6.50
Tonopah Ex	Silver, gold	Nevada			0.10*
Tonopah Mining	Silver, gold, copper	Various	0.75	0.62½	0.62½
United Eastern	Silver, lead	Mexico	0.06½	0.06½	0.06½
United Verde Ex	Copper, gold, silver	Arizona	10	9.00	9.87½
United Zinc Sm	Lead, zinc	Tri-State	3.50	2.00	3.50
Utah-Apex	Lead, zinc, copper	Utah	2.00	1.50	1.50
Wenden Copper	Copper, silver	Arizona	0.37½	0.25	0.25
Yukon Gold	Gold	Yukon	0.37½	0.25	0.25
BOSTON STOCK EXCHANGE					
Ariz. Comm	Copper, gold, silver	Arizona	1.50	1.25	1.37½
East Butte	Copper, gold	Montana	1.12½	1.00	1.12½
Isle Royale	Copper	Michigan	8.50	6.00	7.75
Mohawk Mining	Copper	Michigan	29.00	25.00	28.00
Old Dominion	Copper, gold, silver	Arizona	5.25	5.00	5.00
Utah Met. & Tunnel	Copper, lead, gold	Utah	0.45	0.36	0.40
MONTREAL					
Asbestos Corp.	Asbestos	Quebec	1.00	1.00	1.00
Asbestos Corp., pfd.	Asbestos	Quebec			3.00
Consolidated M. & S.	Lead, zinc, silver	Canada	203	190	200

Company Name	Metals Produced	Location of Properties	High	Low	Last
TORONTO STANDARD STOCK AND MINING EXCHANGE					
Abana Mines	Copper, zinc, silver	Quebec	0.52	0.39	0.42½
Amulet Mines	Copper, zinc, silver	Quebec	0.53	0.35	0.50
Base Metals	Lead, zinc, silver	Brit. Col.	2.95	2.00	2.60
Barry-Hollinger	Gold	Ontario	0.19½	0.13½	0.17
Canam Metals	Lead, zinc, silver	Various	0.19	0.15	0.15
Castle-Trethewey	Silver	Ontario	0.18	0.16	0.16
Central Manitoba	Gold	Manitoba	0.10	0.08	0.10
Coniagas	Holding, silver	Ontario	0.40	0.40	0.40
Falconbridge	Nickel, copper	Ontario	2.75	1.80	2.50
Howey Mines	Gold	Ontario	0.56	0.37	0.39
Keeley	Silver	Ontario	0.30	0.29	0.29
Kirkland Lake	Gold	Ontario	0.60	0.54	0.56
Lake Shore	Gold	Ontario	22.50	21.55	22.25
Sherritt Gordon	Copper, zinc, silver	Manitoba	1.51	1.30	1.31
Siscoe Gold	Gold	Quebec	0.30	0.25	0.26
Sylvanite	Gold	Ontario	0.59	0.43	0.50
Treadwell Yukon	Lead, zinc, silver	Various	4.00	3.50	3.50
Ventures	Holding	Various	1.20	1.05	1.08
Vipond Con	Gold	Ontario	1.32	1.20	1.20
Waite-A.-M.	Copper, zinc, gold	Quebec	3.20	1.40	2.90
Wright-Hargreaves	Gold	Ontario	1.97	1.80	1.82
ST. LOUIS AND CINCINNATI					
Consolidated L. & Z.	Lead, zinc	Tri-State	4.00	2.75	4.00
Eagle-Picher	Lead, zinc, silver	Various	8.50	7.50	8.00
Eagle-Picher, pfd.	Lead, zinc, silver	Various	100	100	100
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS					
California Copper	Copper, gold, silver	California	1.25	0.87½	0.87½
Golden Cycle	Gold	Colorado	14.75	14.25	14.37½
Idaho-Maryland	Gold	California	0.24	0.21	0.23
Portland	Gold	Colorado	0.01½	0.01½	0.01½
Tom Reed	Gold	Arizona	0.89½	0.65	0.80
United Gold	Gold	Colorado	0.09	0.08½	0.08½
SPOKANE					
Constitution	Lead, zinc, silver	Idaho	0.10½	0.07½	0.08
Dayrock	Lead, silver	Idaho	1.72	1.00	1.60
Golconda	Lead, zinc, silver	Idaho	0.58	0.46	0.50
Grandview	Zinc, lead	Wash	0.05½	0.04½	0.05½
Jack Waite Con	Lead, zinc, silver	Idaho	0.07½	0.05½	0.07
Mexican Premier	Lead, silver, gold	Mexico	0.36	0.29	0.32
Montana Mines	Gold, silver	Montana	0.31	0.26	0.27
Noble Five	Lead, zinc	Brit. Col.	0.05½	0.05	0.05
Pend Orielle	Zinc, silver, lead	Wash	1.25	1.10	1.25
Sherman Lead	Lead, silver	Idaho	0.49	0.39½	0.49
Sunshine Mining	Silver, lead, copper	Idaho	1.86	1.40	1.58
Tamarack & Custer	Lead, silver	Idaho	0.40	0.30½	0.39
SALT LAKE CITY					
Chief Con	Lead, silver, gold	Utah	1.05	0.96	0.98
Combined Metals	Zinc, lead, silver	Various	0.12	0.11	0.11
Eureka Bullion	Lead, silver, gold	Utah	0.24½	0.22	0.24
Eureka Lilly	Lead, silver, gold	Utah	0.45	0.37	0.40
Moscow Silver	Silver, lead	Utah	0.85	0.75	0.80
New Quincy	Lead, silver, zinc	Utah	0.18½	0.09	0.09
North Lily	Lead, silver, gold	Utah	1.40	0.90	1.40
Park Bingham	Lead, zinc, silver	Utah	0.07	0.03	0.07
Park City Con	Lead, zinc, silver	Utah	0.36½	0.34	0.34
Rico Argentine	Zinc, lead, silver	Colorado	0.10	0.08	0.09
Silver King Coal	Lead, silver, zinc	Utah	7.75	6.90	7.75
Tintic Lead	Lead, silver, copper	Utah	1.00	1.00	1.00
Tintic Standard	Lead, gold, silver	Utah	5.95	5.10	5.80
Walker Mining	Copper, gold, silver	California	2.52½	2.05	2.52½
‡LONDON					
Anglo American	Holding	Various	22/9	20/7½	21/3
Aramayo Mines	Tin, bismuth, silver	Bolivia	26/10½	21/10½	25/—
Burma Corporation	Lead, silver, zinc	India	11/4½	10/3	10/9
Bwana M'Kubwa	Copper	Rhodesia	14/4½	12/—	13/—
Camp Bird	Holding	Various	9½d	4½d	4½d
Fresnillo	Silver, lead, zinc	Mexico	12/6	11/3	11/3
Frontino & Bolivia	Gold	Colombia	9/3	8/3	8/9
Lake View & Star	Gold	Australia	12/7½	11/—	11/6
Mexican Corporation	Copper, zinc	Mexico	5/6	4/6	5/3
N'Changa Copper	Copper	Rhodesia	61/10½	46/3	48/9
Oroville Dredging	Gold	California	1/5	1/—	1/3
Rhodes. Congo Border	Copper	Rhodesia	312/6	245/—	260/-
Rhodes.-Select. Trust	Copper	Rhodesia	36/10½	26/10½	27/6
Rio Tinto	Copper, pyrites	Spain	715	667/6	700
St. John del Rey	Gold	Brasil	17/—	16/—	16/9
San Francisco Mines	Zinc, lead, silver	Mexico	17/—	13/9	15/6
Santa Gertrudis	Silver, gold	Mexico	9/—	7/4½	7/9
Selukwe	Holding	Africa	3/6	2/6	3/—
So. American Copper	Copper	Venezuela	1/4½	1/1½	1/3
Tanganyika	Holding	Africa	43/3	29/4½	33/1½
Wiluna Gold	Gold	Australia	18/—	17/—	17/3
Union Minière	Copper	Bel.Congo	7,940	7,455	7,455

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Toronto Standard Stock Exchange courtesy the Arthur E. Moysey Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in. †Belgian Francs. ‡The above London quotations are for the month ended July 20.